Demography of AGING

NATIONAL RESEARCH COUNCIL

Demography of Aging

Linda G. Martin and Samuel H. Preston, Editors

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Commission on Behavioral and Social Sciences and Education
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Contributors

JACQUELINE L. ANGEL, Population Research Center, University of Texas at Austin

FRANK D. BEAN, Population Research Center, University of Texas at Austin

RICHARD V. BURKHAUSER, Center for Policy Research, The Maxwell School, Syracuse University

VICKI A. FREEDMAN, Agency for Health Care Policy and Research, U.S. Department of Health and Human Services

OMER R. GALLE, Population Research Center, University of Texas at Austin

DOUGLAS HOLTZ-EAKIN, Metropolitan Studies Program and Economics Department, The Maxwell School, Syracuse University

KEVIN KINSELLA, Center for International Research, Bureau of the Census, U.S. Department of Commerce

RONALD D. LEE, Department of Demography, University of California, Berkeley

KENNETH G. MANTON, Center for Demographic Studies, Duke University

LINDA G. MARTIN, RAND, Santa Monica, California

GEORGE C. MYERS, Center for Demographic Studies, Duke University

SAMUEL H. PRESTON, Population Studies Center, University of Pennsylvania

JOSEPH F. QUINN, Department of Economics, Boston College

TIMOTHY M. SMEEDING, Metropolitan Studies Program and Economics Department, The Maxwell School, Syracuse University

BETH J. SOLDO, Department of Demography, Georgetown University

ERIC STALLARD, Center for Demographic Studies, Duke University

PAUL TAUBMAN, Population Studies Center, University of Pennsylvania

DOUGLAS A. WOLF, Center for Policy Research, The Maxwell School, Syracuse University

Committee on Population

RONALD D. LEE (*Chair*), Department of Demography, University of California, Berkeley

CAROLINE H. BLEDSOE, Department of Anthropology, Northwestern University

JOSE-LUIS BOBADILLA, Population, Health, and Nutrition Department, World Bank, Washington, D.C.

JOHN B. CASTERLINE, Department of Sociology, Brown University

KENNETH H. HILL, Department of Population Dynamics, Johns Hopkins University

DEAN T. JAMISON, Center for Pacific Rim Studies, University of California, Los Angeles

LINDA G. MARTIN, RAND, Santa Monica, California

MARK R. MONTGOMERY, Department of Economics, State University of New York, Stony Brook

ANNE R. PEBLEY, RAND, Santa Monica, California

SAMUEL H. PRESTON, Population Studies Center, University of Pennsylvania and Center for Advanced Study in the Behavioral Sciences, Stanford

RONALD R. RINDFUSS, Department of Sociology, University of North Carolina, Chapel Hill

BETH J. SOLDO, Department of Demography, Georgetown University

MARTA TIENDA, Population Research Center, University of Chicago

AMY O. TSUI, Carolina Population Center, University of North Carolina, Chapel Hill

JOHN HAAGA, *Director*

LINDA G. MARTIN, *Director**

BARNEY COHEN, *Research Associate*

SUSAN COKE, *Senior Project Assistant**

CHRISTINE A. COSTELLO, *Program Officer*

KAREN A. FOOTE, *Research Associate*

JAMES N. GRIBBLE, *Program Officer***

CAROLE L. JOLLY, *Senior Program Officer*

PAULA J. MELVILLE, *Senior Project Assistant*

SUSAN SHUTTLEWORTH, *Senior Project Assistant*

* through June 1993

** through August 1993

Preface

The Committee on Population was established in 1983 to conduct scientific assessments of major population issues and to provide a forum for the discussion and analysis of important public policy issues related to population. It is concerned with questions about the measurement, determinants, and consequences of changes in population size, growth, and distribution that are important to scientists and policy makers in both developed and developing nations.

The committee has a history of activities relating to the demography of aging. Of particular concern have been cross-national research and policy issues, as reflected in its 1988 workshop on aging in developing countries, sponsored by the National Institute of Aging, which focused on health, family, and economic issues. However, the committee has also had an interest in domestic issues of population aging, exemplified in its 1987 publication, *Demographic Change and the Well-Being of Children and the Elderly.* That report, which summarized the discussion and included three papers from a 1985 workshop, considered the status of children and the elderly in the United States, possible demographic factors influencing their status, and their well-being relative to groups of similar ages in other developed countries. The report also discussed the effects of changes in age structure on the economic and fiscal health of the country, at both the local and the federal levels. More recently, the committee cosponsored, with the Division of Health Promotion and Disease Prevention of the Institute of Medicine and the Committee on National Statistics of the National Re search Council, a workshop on forecasting life expectancy, with an emphasis on the United States.

In January 1992, at the request of the Office of Demography of Aging of the National Institute on Aging, the Committee on Population convened a small planning meeting of experts on the demography of aging. This group proposed developing a volume that delineates the field of the demography of aging, highlights the contributions that the demography of aging can make to policy formulation, and summarizes what is known and promising areas for future research in specific subfields. At the planning meeting, it was proposed that papers be commissioned on eight topics:

formal demography of age structure and the life course;

retirement and labor force behavior;

wealth and income;

family demography;

social and medical support: division of labor among families, market, and state;

medical demography;

socioeconomic differentials in health and mortality; and

migration and population redistribution.

The Committee accepted the proposal of the planning group and began to develop the plan for this volume. Authors were selected for each topic, and they were asked to address the following cross-cutting issues, when possible:

- data availability and needs;
- conceptual issues (e.g., micro versus macro approaches, cohort aspects);
- measurement;
- prospects for international comparisons;
- research design;
- heterogeneity; and
- projections.

The committee subsequently decided to add a ninth paper on aging research in developing countries. This set of topics is believed to provide an extensive road map to the subject comprised by the term "demography of aging."

This volume presents revised versions of the nine papers, which were originally presented and discussed at a workshop at the National Research Council in Washington, D.C., on December 10-11, 1992. Also included as an appendix is a letter report to the National Institute on Aging from the committee that summarizes the committee's assessments of and recommen dations for data collection and research that emerged from the papers and discussion.

The Committee on Population and the editors of this volume are grateful to the National Institute on Aging and in particular to the Office of Demography of Aging and its director, Richard Suzman, for financial support, guidance, and assistance. We would also like to thank the participants at the December 1992 workshop for their insightful comments and suggestions and especially recognize the contributions of the formal discussants: James M. Poterba, James W. Vaupel, George Kaplan, Lee Lillard, Robert J. Willis, John B. Casterline, Linda J. Waite, George C. Myers, and John Knodel.

Susan M. Coke, Paula J. Melville, and Susan Shuttleworth all provided superb administrative assistance in organizing the workshop and producing this volume. Florence Poillon and Mendelle T. Berenson skillfully edited the papers, Elaine McGarraugh meticulously prepared the volume for publication, and Eugenia Grohman patiently guided us through the review and production processes. We thank them all. We are also enormously grateful to Barney Cohen for overseeing the final stage of the project and for keeping us more or less on schedule.

LINDA G. MARTIN AND SAMUEL H. PRESTON, EDITORS

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Demography of Aging

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Introduction

Samuel H. Preston and Linda G. Martin

The populations of North America, Latin America, Europe, and Asia are rapidly growing older, primarily as a result of fertility and mortality levels that are below those of the recent past. Even if fertility and mortality levels cease declining, a great deal more aging is in prospect for these regions as their age structures approach the equilibrium that is consistent with their new levels of fertility and mortality.

Table 1-1 presents information on the size, growth, and proportionate representation of the population aged 65 and over, in major regions of the world, from 1955 to 2025. By 2025 the United Nations anticipates that there will be 822 million people in the world aged 65 and over, a number that exceeds the present combined populations of Europe and North America. The elderly population will have grown by a factor of 2.5 between 1990 and 2025. This growth is faster than that of the total population, so that the proportion of the elderly in the world's population will increase from 6.2 to 9.7 percent.

While the growth rate of the total population is expected to decline between 1955-1990 and 1990-2025, the growth rate of the elderly component is expected to accelerate. Most of the growth will occur in developing regions. As recently as 1975, a majority of the world's elderly lived in economically developed regions; by 2025 only 31 percent will do so. How rapidly the aging process will accelerate over the next several decades is indicated by the fact that the proportion of elderly persons in the world's population grew by only 1 percentage point between 1955 and 1990, whereas

TABLE 1-1 Growth of the Population Aged 65 and over by Major World Region, 1955-2025

	Number of Persons Aged 65 and Over in Millions (percentage)					Factor of Growth of the Population Aged 65+	
Region	1955	1975	1990	2005	2025	1955-1990	1990-2025
World	143	232	328	475	822	2.29	2.51
	(5.2)	(5.7)	(6.2)	(7.1)	(9.7)		
More Developed Regions	72	118	145	186	256	2.01	1.76
	(8.1)	(5.7)	(6.2)	(7.1)	(9.7)		
Less Developed Regions	71	114	183	289	566	2.58	3.09
	(3.8)	(3.8)	(4.5)	(5.4)	(8.0)		
Africa	7	12	19	31	63	2.71	3.32
	(3.0)	(3.0)	(3.0)	(3.2)	(4.0)		
Asia	62	96	155	249	470	2.50	3.03
	(4.1)	(4.1)	(5.0)	(6.3)	(9.6)		
Latin America	7	13	21	33	65	3.00	3.10
	(3.6)	(4.1)	(4.8)	(8.6)	(9.2)		
Europe	38	59	68	82	105	1.79	1.54
	(9.2)	(12.3)	(13.4)	(15.4)	(19.4)		
North America	16	25	35	39	67	2.19	1.91
	(8.7)	(10.3)	(12.5)	(12.3)	(18.5)		

NOTE: For projections in 2005 and 2025, the medium variant is used.
SOURCE: Data from United Nations (1993).

it will grow by 3.5 percentage points over the next 35 years, including a 6.3-point increase in developed regions.

Population aging will be one of the most important social phenomena of the next half century. It is important because eligibility for most major social transfer programs are strongly tied to age and so are affected by changes in age population structures. It is important because people of different ages have different capabilities, interests, needs, and intentions, so that shifts in age structure gradually change the points of emphasis on the social landscape and the focus of public attention. And it is important because changes in the aggregate age structure are mirrored within nearly all social institutions, from firms to families. How these institutions accommodate themselves to impending changes in population age structures will have a significant effect on the quality of life in the twenty-first century.

In view of the rapidity and significance of these changes, an increasing number of demographers and other social scientists have begun to examine the implications of population aging for a variety of social and economic processes. A field loosely called "the demography of aging" has emerged in the past decade. The term has become a rather capacious umbrella for a variety of studies addressed to the causes and consequences of population aging. These studies have in common an empirical emphasis, typically using survey or vital statistics data. They also exhibit one or more of the following features:

- an orientation towards intergenerational relations and exchanges, especially within the family;
- a concern with cohorts and the process by which cohorts carry forward their histories into new age categories and replace cohorts with different histories; and
- a focus on the characteristics and behaviors of older people themselves, especially in the critical areas of economics and health.

This volume includes nine chapters that map out the major themes in the demography of aging. The authors, people at the forefront of research in a particular field, provide a state-of- the-art assessment of research and identify the major gaps in data, theory, and research design. Although the focus is on the United States, each chapter also includes some attention to international developments.

In Chapter 2 Ronald Lee develops a demographic accounting framework for evaluating systems of transfer among people in different age groups. He first describes how mortality and fertility levels combine to affect life-cycles and population characteristics. He then combines these demographic structures with age patterns of consumption, production, and social trans fers to show how the balance of flows is influenced by demographic features.

The chapter makes rigorous the notion that, if taxes are paid at an average age that is below that at which benefits are received, as is currently the case in the United States, then a population that is on average older must have a more adverse balance of lifetime transfers than a younger population. The consequences are surprisingly large. For example, a 1-year gain in life expectancy at birth, under conditions of the contemporary United States, will reduce the lifetime value of consumption by 0.9 percent unless labor effort increases. The macrolevel, steady-state relations described by Lee clearly demonstrate the challenges for social policy that are posed by aging populations. They also set the stage for the microlevel analyses that occupy most of the rest of the volume.

Joseph Quinn and Richard Burkhauser in Chapter 3 focus on labor force behavior of older persons. They show that, contrary to the increased work effort needed to avert a decline in life-cycle consumption in an aging population, older workers have been retiring from the labor force at younger ages. The authors provide a comprehensive, largely chronological review of an increasingly sophisticated literature about work incentives for older persons.

Quinn and Burkhauser describe the efforts that researchers have made to characterize those incentives, an effort that necessarily relies on a variety of data sources that extend beyond household surveys. They also describe the evolution of models toward framing research questions in the same sequential manner in which individual workers face retirement questions. The impressive research base that already exists allows the authors to speculate about the future of labor force activity at older ages. Most of the impending changes in incentives—the reduction of pension coverage for American workers, the gradual replacement of defined benefit plans with defined contribution plans, and the changes in Social Security entitlements—suggest a halt or reversal in the movement towards earlier retirement. The authors note, however, that the research base is very thin with respect to female workers, who constitute a large and rapidly growing percentage of the work force.

The economic distinctions between older men and women are highlighted in Chapter 4. Douglas Holtz-Eakin and Timothy Smeeding investigate the economic status of older Americans and compare them with persons in other developed countries. The message is one of diversity. Not only is income more unequally distributed among older Americans than among younger Americans, it is far more unequally distributed among older Americans than among older people in other countries.

Much of the income inequality in the United States is associated with gender and marital status. In comparison with people in other countries, U.S. married couples aged 65 and over are by far the most affluent. In contrast, elderly women living alone in the United States are very poor by international standards. The wider variance in income for older Americans means that, even though their median income is not unusually low relative to that in other countries, they have the highest level of poverty. The authors note that, although the data base for making these assessments of income is relatively firm, the same cannot be said for measures of wealth or intergenerational transfers of resources. Better measures of wealth would also improve income comparisons: for example, 57 percent of older single women in poverty are homeowners, and imputation for the value of those homes would reclassify a large fraction of them out of poverty.

Family relationships are important not only for economic status but for virtually every feature of life. Chapter 5 by Douglas Wolf reviews research that investigates the extent of kinship ties among older people and the degree of residential proximity among kin, including residence in the same household. The emphasis is on ties between older persons and their children.

Wolf notes that there is not a one-to-one correspondence between levels of fertility and mortality and the frequency of kinship ties: patterns of correlation within generations (i.e., in the form of parity-specific fertility rates) or across generations (i.e., intergenerational correlations in fertility or mortality) create far more complex patterns of kinship ties. Family dissolution and reformulation also contribute to greater complexity. After kinship patterns are mapped out, an important research question is clear: Who chooses to live with whom? Identifying the factors affecting the likelihood of coresidence has proven very difficult because coresidence is a joint decision across many potential alternatives for many potential coresidents. Although a fair amount is known about the characteristics of older persons that increase the likelihood of residing with a child—for example, health impairments and low income—much less is known about how the characteristics of offspring affect the choice.

These same questions arise in Chapter 6 by Beth Soldo and Vicki Freedman. They are concerned with understanding the factors that influence the type of care received by older Americans who are disabled in some fashion. These people constitute about 24 percent of the population aged 65 and over.

The possible sources of care are spouses and offspring (thus raising the same issues of research design as in the previous chapter by Wolf), friends, unpaid volunteers, paid caregivers, and public and private institutions. The possible sources of financial support for acquiring such care are oneself, one's family, state subsidies, and donations in kind by caregivers. This complex array of possibilities has proven daunting to researchers, and the chapter by Soldo and Freedman consists of more citations of inadequacy than of triumph in the literature. They have put their fingers on a very weak spot in research on the demography of aging, and one that needs immediate attention in view of potential changes in U.S. social policy regarding the public provision of care.

Changes in the incidence and case-fatality rates of major diseases jointly determine (along with fertility levels) the rate of population aging. These issues, subsumed under the title of medical demography, are the subject of Chapter 7 by Kenneth Manton and Eric Stallard. Disabled people have suffered some disease or injury that has not proven fatal. A reduced incidence of disease or injury will reduce the prevalence of disability, whereas reduced death rates for persons with a particular condition will raise the prevalence.

Manton and Stallard outline a framework for analyzing the relationships among individual health-related behaviors, genetic predispositions, disease incidence and fatality, population aging, and levels of mortality and morbidity. Although this agenda is extremely ambitious, they present illustrations of how models that are biologically less complex can prove misleading. Especially provocative is their presentation and interpretation of evidence that rates of disability have recently declined at older ages in the United States. Because of the high costs of caring for people with health impairments, models that demonstrate the potential effects of various health policies and that accurately project changes in disability rates can be extremely valuable, even when their complexity prevents easy comprehension.

Samuel Preston and Paul Taubman in Chapter 8 focus on the class distribution, rather than the level, of mortality and morbidity. Using educational attainment as their basic measure of social class, they show that adult mortality differentials widened between 1960 and the late 1970s, although there is some disagreement among data sources for the end of the period. Differentials among men exceed those among women, in part because of the countervailing pattern of breast cancer among the latter. For both sexes, the magnitude of class differences appears comparable to those in European countries.

Class differences in mortality are not readily attributable to such standard biomedical risk factors as blood pressure and smoking; the possibility that social-psychological factors, including social relations, play an important role deserves more attention than it has received. Most of the mortality difference between blacks and whites appears attributable to the adverse distribution of blacks on socioeconomic variables. The evidence that mortality differentials at older ages widened during the period when Medicare was introduced suggests that access to health care may not play a dominant role among the determinants of mortality levels.

In Chapter 9 Frank Bean, George Myers, Jacqueline Angel, and Omer Galle also disaggregate the older population, examining its geographic concentration by region and size of place. They note that the greater concentration of the elderly, and especially the population aged 85 and over, in the

Northeast and Midwest raises a host of social policy issues for local governments.

The authors note the dearth of studies that attempt to identify the sources of variation in rates of aging among different localities. Certainly, migration patterns of both the elderly and nonelderly play an important role. Migration among older people appears less responsive to the economic motives that are paramount among younger people. In particular, the principal motives for migration at ages 70 and over appear to be related to family proximity and diminished health. The possibility of migration obviously affects older people's opportunities with respect to caregiving, coresidence, and economic status in ways that need to be better reflected in research.

Linda Martin and Kevin Kinsella in Chapter 10 revisit many of the themes of the preceding eight chapters, but they focus on research in developing countries. Apart from Africa, many of these countries are aging as rapidly as the United States, and many of the same processes are apparent. For example, age at retirement seems to be declining as incomes rise, and residence of elderly people with their children is also declining, at least in Asia, which has been the subject of the most research. As in the United States, older people with more income are more likely to be living apart from their children. However, coresidence is still the norm, and children appear to provide a higher share of income for the elderly in Asia than is or perhaps ever was the case in the West. The authors emphasize the shortage of research and research materials in developing countries. Much of what is known is the result of censuses and a limited number of one-round cross-sectional surveys. The longitudinal studies that are providing so much detail on health, labor force, and family processes in the United States are almost completely absent in developing countries. The neglect of aging research in Latin America is especially surprising in view of the rapid aging of its population and its sizable number of social scientists.

The field of the demography of aging, an offspring of mixed parentage, is rapidly approaching maturity as a subdiscipline with recognizable themes and approaches. This volume provides a kind of inventory of progress to date. Whatever success it achieves is attributable to a group of authors who were unusually diligent, perceptive, and cooperative. The editors are most grateful.

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2

The Formal Demography of Population Aging, Transfers, and the Economic Life Cycle

Ronald D. Lee

INTRODUCTION

The human life-cycle has two stages of dependency—childhood and old age—separated by a long stage of surplus production. Dependent age groups are sustained by flows of resources upwards and downwards by age from the more productive stage in the middle. These resource flows occur through three institutional channels: the family, the public sector, and financial markets. Through each channel, resource reallocation takes one of three forms: capital formation, credit transactions, and interage transfers. As fertility and mortality decline, the population age distribution shifts toward older ages, which changes the terms on which these resource flows take place. The public sector, through which some of the transfer flows are channeled, is particularly sensitive to the consequences of these age distribution changes. The governments of many industrial nations are concerned that transfers to the elderly, which are already costly, will be raised rapidly by population aging in the early twentieth century. Many Third World nations, preoccupied in the past with the costs of their young populations'

The author is grateful to Robert Willis for many helpful discussions and for the extensive use made of his earlier work, and to Michael Anderson for excellent research assistance. James Poterba and Samuel Preston provided helpful comments on an earlier draft. Research support from the Institute for International Studies of the University of California at Berkeley is gratefully acknowledged.

high child dependency burden, are now beginning to worry instead about the costs of impending population aging.

This chapter develops an accounting framework for evaluating systems of interage transfers, and examines how such systems are affected by changing population age distributions. To understand the role of transfers in achieving a desirable allocation of consumption over the life-cycle, it is necessary to consider them in relation to the other forms of reallocation: credit and capital. There is a rich and controversial literature on the relation between transfer systems and capital accumulation: Does life-cycle saving account for the capital stock of industrial nations (Modigliani, 1988; Tobin, 1967)? Or is the desire to leave bequests responsible (Kotlikoff and Summers, 1981, 1988)? Do public sector pension systems undermine private saving (Feldstein, 1974)? Or do elderly parents simply increase their familial transfers to their children to offset the pensions (Barro, 1974)? Transfers may be used to achieve efficient allocations over the life-cycle that are unattainable via competitive market mechanisms (Samuelson, 1958), and if transfers upwards or downwards by age are needed to achieve efficient allocations, that fact tells us that the population growth rate is less than or more than the optimal rate (Samuelson, 1975, 1976; Willis, 1988; Lee, in press, b). These are issues that a coherent accounting framework may help to clarify.

The theoretical basis for a comprehensive framework for studying the reallocation of resources across age in general, and transfers in particular, has been laid by economic and demographic research over the past 35 years. Macroeconomic models with "overlapping generations" sprang from the seminal work of Samuelson (1958) and, later, Diamond (1965). The literature has developed to the point that there is now a textbook that teaches macroeconomic theory entirely from the point of view of a simple model of economies with overlapping generations (McCandless, 1991). The models have been used to explore such diverse topics as the existence of money, the rate of interest, aggregate savings rates, the Ricardian equivalence theorem, optimal population growth rates, economic fluctuations, and so on. These important developments in economic theory pave the way for a deeper integration of demography and macroeconomics than has yet proven possible. However, perhaps because of the wish to examine nonsteady-state situations, the demographic models used by most mainline economists are very simplistic: the life-cycle typically consists of two broad age groups, workers and retirees, or young and old, with perfect survival until the end of the second. Childhood is often ignored, and life really begins at labor market entry. This life-cycle incorporates only one period of dependency rather than two. In such a demographic world (used all the way through the McCandless textbook), some of the most basic questions cannot be properly posed or will receive misleading answers. This is true of most questions concerning aging, such as the effect of mortality change on saving behavior or capital accumulation, or the effect of slower growth due to lower fertility, which will alter the share of life-cycle resources devoted to children and alter saving behavior in complex ways (see Mason, 1987). Many interesting empirical questions are also overlooked, including those that involve the interaction of age distribution with institutional context.

Largely ignored by mainline economists, a few economic demographers have begun to explore the interface of richer demographic models and the overlapping generation models of economists. Arthur and McNicoll (1978) published a brief but seminal comment on a paper by Samuelson (1975). Willis (1988), building on Gale (1973), published an important paper incorporating familial and public transfer systems into an accounting framework that related flows to stocks, and on which the work proposed here leans heavily. Lee (1980, in press, a) and Lee and Lapkoff (1988) also contributed analytic and empirical studies and developed early versions of the approach proposed here. On the more demographic side, Keyfitz (1985, 1988) and Bourgeois-Pichat (1978) developed formal analyses of the demography of funded and unfunded pension systems, and Preston (1982) developed and applied analytic tools relating the distribution of characteristics over the individual life-cycle to the distribution of characteristics in a stable population, and showed how these distributions are affected by changes in fertility and mortality.

This chapter develops a conceptual and accounting framework that builds on these two approaches and seeks to bridge the gap between them. Parts are heavily influenced by Willis (1988). The past literature in both demography and economics has paid insufficient attention to mortality change, and this chapter also offers some advances in that direction. At the same time, the analysis here is limited to comparative steady states and mainly to the special case of steady states with optimal saving and investment. These are serious limitations in the United States since recent decades have been marked by major changes in mortality, rates of inflation, real interest rates, regulations governing Social Security and private pensions, rates of real wage growth, rates of appreciation of housing, and so on.

SOME ANALYTICS OF AGING IN STABLE POPULATIONS

In a closed population, population aging can occur due either to decline in fertility or to decline in mortality, and these have quite different effects. Nonetheless, the distinction between the effects of changing fertility and changing mortality is not the most helpful one.

Let $p(x)$ be the probability of survival from birth to age x, let $B(t)$ be the number of births at t (actually, the number between t and $t + dt$), and let n be the growth rate of the stable population. Then the stable population age distribution at time t is $N(x,t) = B(t)e^{-nx}p(x)$. We can divide by population size to find the proportional age distribution, $be^{-nx}p(x)$, where b is the crude birth rate; b is simply a scaling factor here, the same for every age. The natural decomposition, therefore, is into a "rate of growth" effect, due to n, and a "life-cycle" effect or "individual aging" effect, due to the survival schedule, $p(x)$.

When fertility changes, this affects the rate of growth, n, but not $p(x)$. Therefore fertility has only a rate of growth effect. Higher fertility raises n, which increases the size of more recently born cohorts relative to older ones and therefore makes the population younger.

A mortality decline is of course reflected in $p(x)$, which leads to individual aging, tending to make the population older. However, lower mortality also raises the population growth rate, n, since more women survive to childbearing age. In this way, lower mortality tends to make the population younger. The net effect of mortality decline is therefore ambiguous, and can in fact make the population either younger or older, depending on the pattern of mortality change, which in turn depends on the initial level of mortality. Figure 2-1 depicts this decomposition.

The Rate of Growth Effect

Fertility Change

Let us consider more formally the way that fertility and mortality affect the population age distribution through the rate of growth and individual

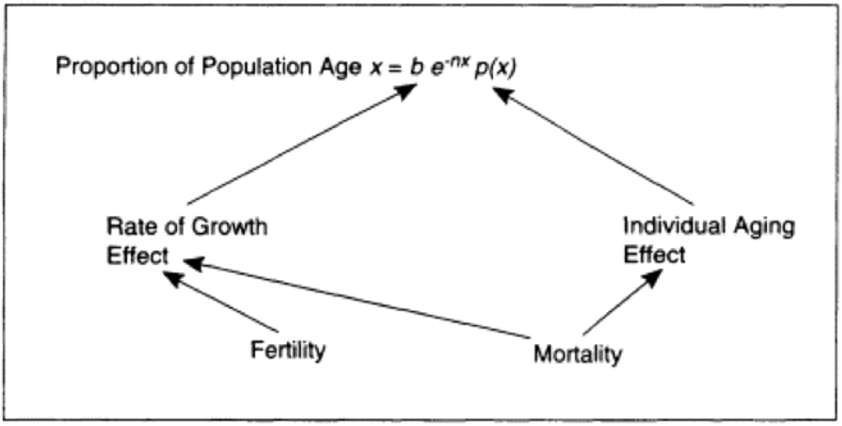

Figure 2-1
Fertility, mortality, and stable age distributions.

aging. Let F be the total fertility rate, let sr be the proportion of births that is female, and let A_f be the mean age of childbearing in the stationary population; $p(A_f)$ is then the proportion of female births surviving to the mean age of childbearing. To a linear approximation, the population growth rate is given by[1]

$$n = \ln[p(A_f) \times F \times sr] / A_f \ .$$

The effect on n of a change in F is found by differentiating this expression for n

$$\partial n/\partial F = 1/(F \times A_f) \ .$$

Note that while the effect of fertility change depends on its initial level, it is independent of the level of mortality, to a first approximation.

Mortality Change

Let i be some index of the level of mortality, such that the survival probabilities vary with i. For any level of i there will be some corresponding level of life expectancy at birth, e_0. The scaling of index i is arbitrary. It will be convenient to choose a scale such that in the neighborhood of any given level of life expectancy, a one-unit change in i corresponds to a change of 1 year in life expectancy; that is, $d(e_0)/di = 1$.

The effect on n of a change in mortality, indexed by i, is given by

$$\frac{\partial n}{\partial i} \approx \frac{\partial p(A_f)/\partial i}{p(A_f) \times A_f} \ .$$

The effect of mortality decline on the population growth rate is independent of the level of fertility, to a first approximation. Note that $p(A_f)$ is bounded above by unity, so that once mortality is already very low, further declines in mortality can have very little effect on the population growth rate. Figure 2-2 plots $\partial n/\partial i$ as calculated from Coale-Demeny model life tables, where i is scaled so that a unit change corresponds to a gain in e_0 by one year. Figure 2-2 shows how $\partial n/\partial i$ changes, depending on the initial level of life expectancy, for life expectancy from 20 to 80 years. When mortality is initially very high, a 1-year gain from a life expectancy of 20 years to a life expectancy of 21 years leads to an increase in the population growth rate by 0.16 percent per year. When mortality is very low, a 1-year gain in life expectancy from 79 years to 80 years would raise the population growth rate by less than 0.01 percent per year, a tiny amount.

[1] In the following expression, In $[p(A_f)]/A_f$ equals minus the mean age-specific growth rate between ages 0 and A_f.

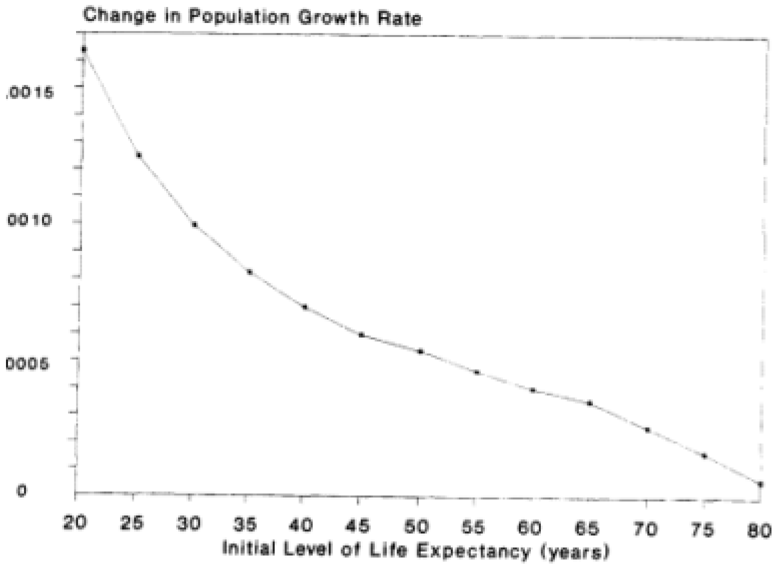

Figure 2-2
The effect of a 1-year gain in life expectancy on the population growth rate, from differing initial levels of life expectancy ($\partial n/\partial i$).
SOURCE: Calculated from Coale-Demeny (1983) model life tables (west females).

The Life-Cycle Effect, or Individual Aging

The shape of the individual life-cycle is described, from a demographic point of view, by the distribution of expected person years lived by age. Ex post, every individual simply lives until death, which is a discrete event. But in prospect, the individual faces a series of probabilities of survival, $p(x)$, which change with age. We can also think of $p(x)$ as describing the density of expected person-years lived at age x for an individual at birth. Expectation of life at birth, e_0, is simply the integral over all ages of $p(x)$; put differently, it is the sum over all ages of the expected person-years lived.

The shape of the demographic life-cycle depends on the severity of the mortality regime: under high mortality, the proportion of the life-cycle lived in the third stage, old age, is relatively small, and under very low mortality it is relatively high. Figure 2-3 plots the number of person-years lived in each of the three stylized life-cycle stages for different mortality regimes indexed by e_0, life expectancy at birth.[2] When life expectancy is

[2] I have used the Coale-Demeny (1983) model life-table system, west female.

20, only 0.6 of a person-year is lived at age 65 and above; when life expectancy is 80, 16 years are. This is a 27-fold increase. Person-years lived in childhood increase from 7.2 to 14.9, just more than doubling. Person-years lived in the working ages rise from 12.2 to 49.0, quadrupling. This is a different pattern than most of us would expect, since it is well known that, historically, mortality has declined most rapidly in childhood and least rapidly at the older ages.[3]

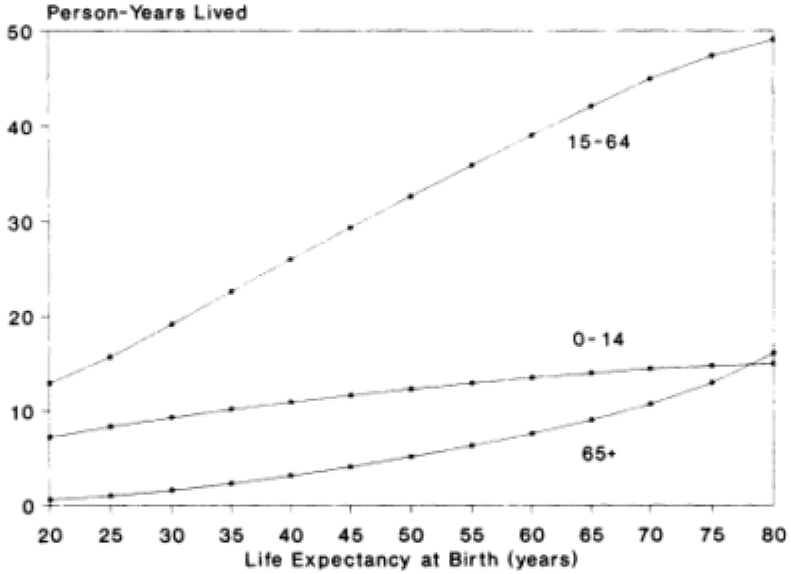

Figure 2-3

Person-years lived in each life-cycle stage, by life expectancy.

SOURCE: Calculated from Coale-Demeny (1983) model life tables (west females).

Figure 2-4 shows how the proportion of the life-cycle spent in each stage changes as we pass from the high-mortality regime to a low-mortality regime. The proportion of the life-cycle spent in the working years changes little; the proportion spent in childhood declines markedly; and the proportion spent in old age increases dramatically.

Recall that life expectancy is the sum over all ages of *p(x)*. If life

[3] It is easy to see, however, that proportional change in person-years lived at any age is nondecreasing with age. If mortality falls at all ages, then this proportion will increase monotonically with age, even if declines are greatest at younger ages.

expectancy increases by 1 year, then the sum of *p(x)* must also increase by 1 year. Put differently, the plot of the changes in *p(x)* when life expectancy changes by 1 year gives us an additive decomposition of that 1 year into gains in person-years lived at the various ages. Figure 2-5 plots *dp(x)/di* for various initial levels of life expectancy, showing how these gains in person-years are distributed across the three life-cycle stages, and how that distribution varies from initially low to initially high levels of life expectancy.[4] For example, by starting at a life expectancy of 20, if life expectancy were

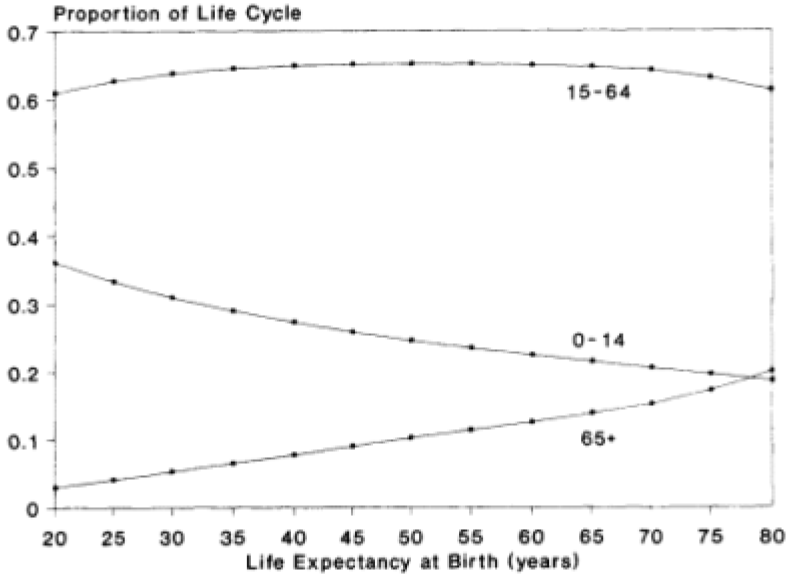

Figure 2-4
Proportion of life cycle lived in life-cycle stage, by life expectancy.
SOURCE: Calculated from Coale-Demeny (1983) model life tables (west females).

[4] We could, for example, think of *i* as equaling 0.4 of one "level" in the Coale-Demeny model life-table system, since one level corresponds to an increment of 2.5 years of e_0. More generally, however, we could simply take two survival schedules, call them *p(x)* and *p^(x),* from two actual life tables with life expectancies at birth of e_0 and e_0^. Then *dp(x,i)/di* is estimated by [*p(x)-p^(x)*]/(e_0-e_0^). We could also readily derive *dp(x)/di* under simple assumptions about mortality change, such as the "neutral" mortality assumption of constant additive changes in the force of mortality at all ages, or alternatively on the assumption that the force of mortality changes proportionately at all ages. Both of these assumptions are quite poor as approximations to the age pattern of actual mortality change, however.

to increase to 21 then, according to the Coale-Demeny life-table system, this would consist of 0.22 year for children, 0.70 year for the working ages, and 0.08 year for the elderly. When initial life expectancy is 75, however, as it is now in the United States, then a gain of 1 year in life expectancy would be distributed as only 0.04 year to children, only 0.34 year to the working ages, and 0.62 year to the elderly.

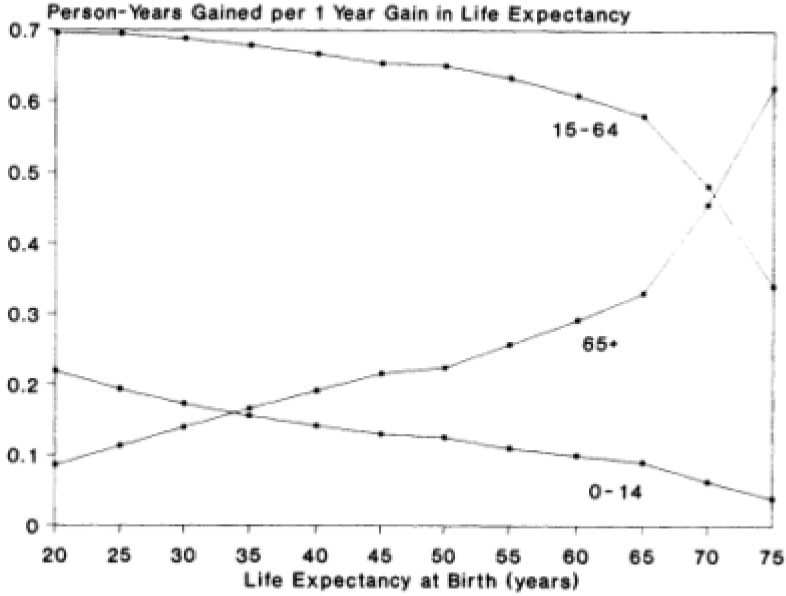

Figure 2-5
Person-years gained in each life-cycle stage when life expectancy increases by 1 year, by initial level of life expectancy.
SOURCE: Calculated from Coale-Demeny (1983) model life tables (west females).

We have now considered the effects of fertility and mortality on the population age distribution through the rate of growth effect and the life-cycle effect. While I have described the sign and magnitude of each effect, I have not combined them all in an appropriately weighted combination to find their net effect on population aging. I am not doing this here, in part because it is not useful for the analysis later in this chapter, and, in part, because it has been done elsewhere (see, for example, Coale, 1972). Suffice it to say here that fertility decline unambiguously causes population aging. Mortality decline starting from very high mortality actually makes populations younger, as the rate of growth effect overwhelms the individual aging effect. However, when starting from lower levels of mortality, the individual aging effect outweighs the rate of growth effect, and the population becomes older.

THE ECONOMIC LIFE-CYCLE AND AGGREGATE CONSTRAINTS

We now turn from the formal demography of aging to the economics of population age distributions. We can carry out our analysis at the level of either the individual or the household. Individuals live in households, and consumption in households is subject to resource pooling, scale economies, and public goods. Furthermore, children are not responsible for financing or choosing their own level of consumption; instead, this is done by their parents. For these reasons, the household accounting framework is appealing. However, the household framework also presents serious analytic difficulties: the dissolution and reconstitution of households over the life-cycle, the presence of multiple adults of different ages in the household, and covariation of household headship propensities with earnings or wealth of individuals. Because of these difficulties with the household framework, I employ the individual accounting framework predominantly here, despite its occasional artificiality in dealing with children. For a household-based analysis, see Lee (in press, b). Some technical details on the household accounting framework are provided in the appendix to this chapter.

The Economic life-cycle

The human life-cycle begins and ends with stages of dependency, in the sense that consumption exceeds labor earnings. This generalization applies on average to age groups, but not necessarily to individuals so far as old age is concerned. The average shape appears to be universal, although ages and extent of dependency may vary widely from population to population. It arises from the combined influence of physiology, culture, institutions, and economic choice, in ways that we take as given.[5]

Figure 2-6 shows profiles of labor earning and consumption for U.S. households by age of respondent for 1987. Earnings are before taxes and include employers' contributions to Social Security, as well as fringe benefits. Quinn and Burkhauser, in this volume, discuss some of the economic and social factors shaping this age profile and the way it has changed over time. If labor markets are competitive, then this age profile reflects the

[5] There is an extensive literature on the economics of retirement (Hurd, 1990) and on the physiology of aging. A delayed exit from childhood dependency is not simply a function of the educational system; long delayed transitions to economic adulthood are also observed in some traditional preindustrial societies (Sahlins, 1972; Bledsoe and Cohen, 1993).

efficiency of labor at each age, as well as the hours of labor supplied, for surviving individuals at each age, averaged across sex. Consequently this age profile can be used to calculate the aggregate quantity of labor in efficiency units as a weighted sum of the population age distribution. When the population age distribution changes, for example as a result of population aging, this age profile permits assessment of the consequences for aggregate production. Consumption includes in-kind public sector transfers (health, education, food stamps, housing benefits) and the imputed value of services from owner-occupied housing, automobiles, and consumer durables (for details, see Lee, in press, b).

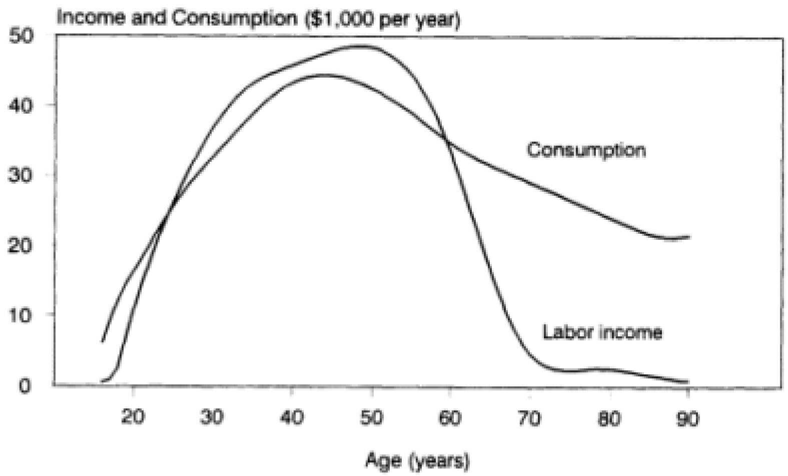

Figure 2-6
Labor income and consumption by age of household respondent.
SOURCE: Calculated from 1987 U.S. Consumer Expenditure Survey.

Reallocation Across Age and Time

The household age profiles in Figure 2-6 indicate that old households are able, on average, to consume far more than they produce through their own labor, whereas young households consume slightly more than they produce. Evidently there has been a reallocation of output from more productive to less productive age groups. Such reallocations take one of three forms: credit, capital accumulation, or transfers. The defining feature of transfers is that unlike borrowing or lending, they involve no quid pro quo.[6]

[6] As I am using the term, one could not ask whether there was an exchange motive for a transfer. If there is an exchange motive for a familial transaction then it involves some form of familial credit. To the extent that implicit interest rates for the transaction differ from the market interest rate, a transfer takes place.

TABLE 2-1 Resource Reallocation Across Age and Time

	Institution		
Form	Family	Market	Public Sector
Capital	House Car Consumer durables Inventories Education	Factories Inventories Farms	Social infrastructure (hospitals, roads airports, government buildings)
Transfers	Child rearing College costs Gifts Bequests Help to elderly	Government debt	Public education Medicaid, Medicare Social Security Food stamps Aid for dependent children
Borrowing/ lending	Familial loans "Transfers" with a quid pro quo	Credit markets (mortgages, credit cards, bond issues)	Government loans

Each of these three forms of reallocation can take place through each of three kinds of institutions: the family, the public sector, or the market.[7] Table 2-1 provides examples of each form of reallocation as achieved through each institution.

Net worth, which includes debt or credit plus the value of physical assets and other financial assets, is a familiar concept. Estimates of average net worth for age groups are available. For our purposes, it is helpful to extend this familiar concept of age-specific net worth or wealth to include transfer debt or transfer wealth for an age group. This is defined as the present value of expected transfers to be received in the future, minus the expected value of transfers to be made in the future. Under steady-state conditions, patterns of transfers will be repeated generation after generation, so these average expectations for age groups are well defined, even though no particular individual is obligated to leave a particular size bequest, for example.

Using the data shown in Figure 2-6, we can calculate the life-cycle wealth or debt accumulated by a cohort up to each age *x*, per original member of the cohort (equations are derived later). Results of such a calculation are shown in Figure 2-7. This figure looks very different from

[7] Other institutions, such as charities or tribal groups, may also play a role.

most plots of wealth by age, for several reasons. First, it is plotted per original member of the birth cohort rather than per surviving member. Second, it includes Social Security and Medicare wealth, which decline steeply with age after the early 60s, as remaining person-years of life decline. Third, under the golden rule assumption, the average person dies with zero wealth, and the constituent age profiles have been adjusted to ensure this. Fourth, it only includes wealth held for purposes of spreading consumption over the life-cycle, not wealth held for purposes of leaving bequests or making other transfers. Furthermore, it assumes that the consumption-spreading motive is actuarially derived, and if people actually hold extra wealth beyond that necessary to consume for the average length of life, that extra wealth is not counted here.

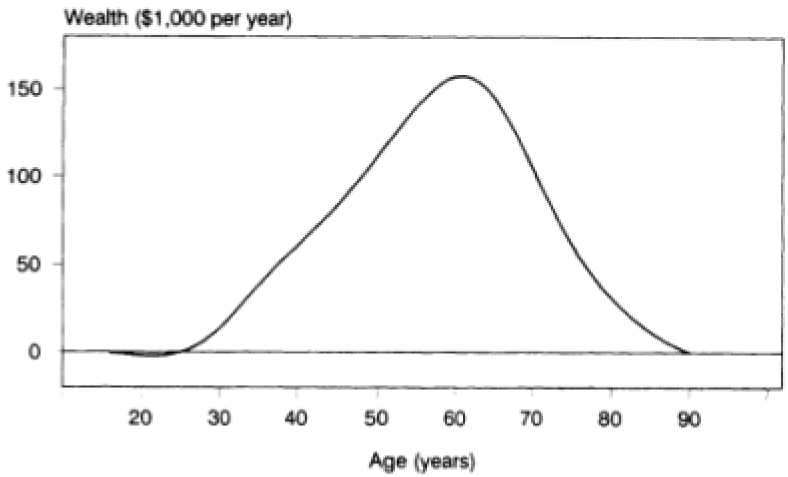

Figure 2-7
Total wealth per original birth cohort member, by current age of cohort ($r = n = 0$).
SOURCE: Calculated from 1987 U.S. Consumer Expenditure Survey.

Social Security wealth is one important portion of total life-cycle wealth; it is plotted in Figure 2-8. At age 60, it accounts for about 45 percent of total life-cycle wealth. Note that it starts at 0 at labor market entry, then rises smoothly to about $65,000 in the early 60s. It then falls to 0 in step with declining remaining person-years to be lived by the cohort.

With this generalization of the concept of wealth or debt, we can say that the age profiles of labor earnings and consumption give rise to a *demand* for a certain amount of wealth at each age in terms of ex ante plans, or entail a certain age profile of wealth ex post. If we sum these age-specific wealth functions weighted by the entire population age distribution, then we find the aggregate demand for wealth in the population.[8] Populations in which child dependency dominates tend to consume, on average, before they produce and therefore have a negative aggregate demand for wealth, that is, a demand for debt. Populations in which old-age dependency dominates tend to consume, on average, after they have produced and therefore have a positive aggregate demand for wealth. I show that in any case, this aggregate demand for wealth per person, *W,* must equal the value of the aggregate capital stock, *K,* plus the value of transfer wealth, *T.* The aggregate value of credit, *M,* must, of its nature, be zero (with government debt and foreign participation in credit markets ignored). Thus society as a whole cannot use credit to satisfy its aggregate demand for positive or negative wealth. For this reason, there are some average life-cycle consumption paths that cannot be attained through competitive markets if physical accumulation is not possible, as Samuelson (1958) pointed out. These ideas are developed more formally below.

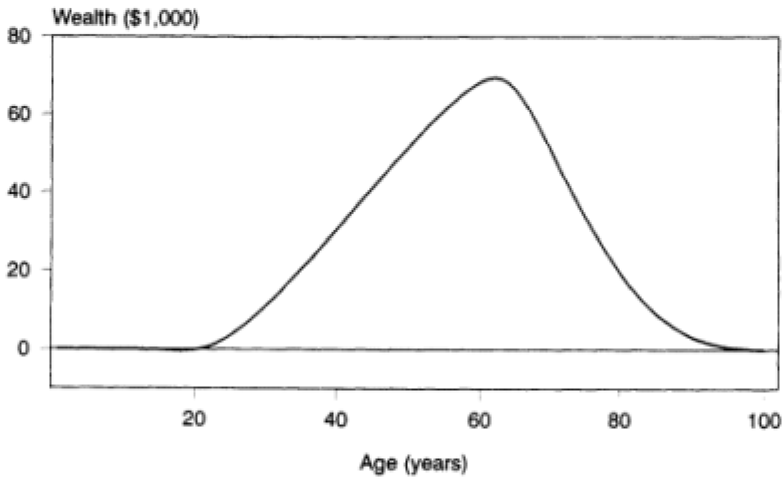

Figure 2-8
Social Security wealth per original birth cohort member, by age of cohort ($r = n = 0$).
SOURCE: Calculated from 1987 U.S. Consumer Expenditure Survey.

[8] This is what Kotlikoff and Summers (1981) refer to as "life-cycle wealth," which they denote *L.*

The Economic Demography of Age Accounts

Consider a closed stable population in which age profiles of labor earning, $y_1(x)$, and consumption, $c(x)$, are fixed. The economy, which is closed, is on a golden rule steady-state growth path, so that the interest rate, r, equals the population growth rate, n, plus the rate of labor-augmenting technical progress, λ, and aggregate consumption equals aggregate labor earnings. Labor earnings depend on physical capital per efficiency unit of labor, k, and in a more complete analysis would depend on the education of each age group as well. Capital is homogeneous and indestructible. The earnings profile and the cross-sectional consumption profile both shift upward proportionately at the exponential rate λ. In the analysis below, λ is taken to be zero, but it is easily shown that all the results continue to hold more generally, except that per capita averages have an exponential trend when $\lambda \neq 0$, which does not affect the results of interest. It should be kept in mind that when, in the following, I say that $r = n = 0$, the results also hold for $r = n + \lambda$, which, based on historical experience, might be about 0.02 per year.

Transfer patterns are taken as fixed and exogenous, for the most part. Bequests are treated as if they were *inter vivos* transfers, without loss of generality as long as mortality is held constant. All public sector transfer budgets are taken by definition of transfers to be balanced; the partially funded portion of Social Security is viewed as government saving, rather than as a transfer. Money as a store of value does not exist. The public sector provides no goods and services except as transfers.

Consumption and Labor Earnings

Let $c(x)$ be per capita consumption at age x. Total consumption by the population in some year can be found by multiplying the population at age x by $c(x)$ and integrating over all ages. Dividing this by total population, we get per capita consumption, c. If we instead divide total consumption by the number of births, $B(t)$, then in a stable population we will get

$$C = \int_0^{\omega} e^{-nx} p(x) c(x) dx .$$

In both cases, the quantity is invariant over time in a stable population with $\lambda = 0$. The variable C can be seen to be the present value of expected life-cycle consumption with a discount rate of n. That is, if we interpret $p(x)$ as the probability of being alive at age x, then $p(x)c(x)$ is expected consumption at age x as viewed from age 0, and e^{-nx} is the discount factor. (The interpretation for a household is more complicated; see the appendix to this chapter.) Evidently per capita consumption, c, is related to the present value of life-cycle consumption (with discount rate n) by $C = c/b$. Per capita labor income in a stable population, denoted y_1, is defined similarly. The present value of expected life-cycle labor earnings, discounted at n, is denoted Y_1. This equals y_1/b and is given by

$$Y_l = \int_0^{\omega} e^{-nx} p(x) y_l(x) dx .$$

In a golden rule population, $C = Y_1$ (or equivalently, $c = y_1$).

It is easily shown that $\partial c/\partial n = -k$ across golden rule steady states, so population growth unambiguously reduces per capita consumption in neoclassical growth models of this type.[9] However, this need not be true for life-cycle consumption, C: even while per capita consumption, c, is falling with more rapid growth, the present value of expected life-cycle consumption could be rising—or could be falling even more rapidly than c. This possibility is at the heart of concerns about the consequences of aging due to slowing population growth. Transfers, as we see later, play a central role in determining the outcome.

Transfers

Assume that a system of transfers is established by some combination of legislation, social norms, and individual choices, such that on average an individual age x makes transfers to others in the amount $\tau^-(x)$, and receives transfers from others in the amount $\tau^+(x)$, for a net gain or loss of $\tau(x) = \tau^+(x)-\tau^-(x)$. These are averages for age groups and need not hold for individuals. It is clear that the societal total of all transfers among age groups at any instant must sum to zero, because every transfer given is also a transfer received. For present purposes, I assume that all public sector transfers are also strictly pay-as-you-go (PAYGO); that is, current program expenditures are exactly balanced by current program taxes, with no deficit and no surplus.[10]

In a stable population with a strictly PAYGO system of transfers, the following social budget constraint must hold, whether or not the economy is golden rule:

$$\int_0^{\omega} e^{-nx} p(x) \tau(x) dx = 0 .$$

[9] In recent years there has been increasing interest in growth models for which this is not necessarily true; see Romer (1990) and Lee (1988) for examples.

[10] The Social Security program in the United States currently is designed to accumulate a surplus to anticipate the baby boom's retirement. I view this as the government does in practice: it simply makes the federal deficit a little lower than it would otherwise be.

This cross-sectional budget constraint can also be given a life-cycle interpretation: the present value of net transfers over the life-cycle, discounted by the population growth rate, is 0, so the implicit rate of return earned through the transfer system is n, the population growth rate (or $n + \lambda$ if there is labor-augmenting technical progress). This result is well known for the Social Security system but holds more generally for every PAYGO transfer subsystem, including bequests and other familial transfers.

Government Debt

Suppose that government debt is held by individuals in the form of bonds, which appreciate in value at rate n, and may be bought or sold at any time. Let $d^-(x)$ be purchases of government bonds by individuals age x, and let $d^+(x)$ be sales of bonds, so that $d(x)$, their difference, is net sales of bonds and represents an inflow of funds to the individual's budget. In golden rule steady state, the aggregate value of outstanding government debt must grow at rate n, which is exactly the rate at which the value of the existing bonds at any moment grows. Therefore the government issues no new bonds, and all bond transactions are between individuals. It follows that their value must sum to zero across all individuals, so that

$$\int_0^{\omega} e^{-nx} p(x) d(x) dx = 0 .$$

In fact, government debt is, in some important respects, similar to government transfers: the young buy bonds that, in later years when they are older, are sold once again to young households. They differ in that there is no compulsion to buy bonds and in that the bonds are salable and bequeathable unlike other transfer wealth. It is convenient in what follows to group government debt with other transfers, denoting it with a superscript D, as in τ^D and T^D.

Credit

Assume that the age group aged x borrows an amount $m^+(x)$ and loans an amount $m^-(x)$ for a net amount borrowed equal to their sum, $m(x)$. Such loans take place through the family, the market, and possibly the public sector. We have already treated government debt separately. Under the assumption that the economy is closed to foreign participation in credit markets, and by treating the borrowing and lending of the private nonhousehold sector as adhering to the individuals holding equity in these firms, it must be the case that the flows of borrowing and lending add to zero across the population at all times, so that

$$\int_0^{\omega} e^{-nx} p(x) m(x) dx = 0 \,.$$

Investment in Capital

Let $i(x) = i^-(x)-i^+(x)$ be net investment in capital, K, by individuals at age x. This is defined such that positive i indicates a net flow of funds out of the individual's budget to purchase K, in contrast to the other variables, which indicate inflows (an arbitrary decision). If we integrate this over all ages, we should get the aggregate flow of investment per individual in the population. In a golden rule economy, this must equal income earned by capital, nK:

$$\int_0^{\omega} e^{-nx} p(x) i(x) dx = nK \,.$$

Budget Constraint for Flows

We can now gather together all these different flows into and out of the individual budget and relate them one to the other in an aggregate age-specific constraint on the flows:

$$0 = y_l(x) - c(x) + \tau(x) + m(x) - i(x) + n[K(x) + M(x)]/p(x) \,,$$

where $K(x)$ and $M(x)$ are stocks of capital and credit held by individuals at age x expressed per member of the original birth cohort, rather than per surviving member of the cohort.

Aggregate Wealth Accounting

Now note that the accumulation of assets in the form of capital, K, and credit, M, is governed by the following differential equations: $dK(x)/dx = p(x)i(x)$ and $dM(x)/dx = -p(x)m(x)$, where the negative sign in the latter results from having defined m as net flows into the budget.

Grouping these assets together and substituting for $i(x)$-$m(x)$, we have

$$\frac{dK(x)}{dx} + \frac{dM(x)}{dx} = p(x)[y_x(x) - c(x) + \tau(x)] + n[K(x) + M(x)] \,.$$

From this it follows that

$$K(x) + M(x) = \int_0^{\omega} e^{n(x-a)} p(x)[y_l(a) - c(a) + \tau(a)] da \,.$$

Consider the bracketed terms in the integral. Recall that transfer wealth at some age is just the present value of the expected difference between transfers to be received and made in the future. This is simply the negative of the integral shown, as follows from the fact that transfer flows integrate to zero over the population (see above). Thus one component of the integral is simply *-T(x).* The other component can be seen to be the quantity of life-cycle wealth accumulated up to age *x* per original member of the cohort, where a surplus (or deficit) of labor earnings over consumption at age *a* is cumulated up to age *x*, earning interest at the rate *n.* Thus the other component of the integral is *W(x).* We then have

$$W(x) = K(x) + T(x) + M(x) = K(x) + T^F(x) + T^G(x) + T^D(x) + M(x).$$

Life-cycle wealth at age x can be held as capital, transfer wealth (including government debt), or credit.

We can now integrate over all age groups, weighted by initial birth cohort size, $B(t)e^{-nx}$. If we divide this by the size of the population, or alternatively weight by be^{-nx}, then we get wealth per capita. For example

$$K = b\int_0^{\omega} e^{-nx} K(x)dx .$$

In this way, we find $W = K+T$, recalling that M must be zero.

In principle, this integral should cover all cohorts that ever existed, because wealth accumulated by distant cohorts may have survived their lifetimes and may continue to exist and earn interest at time *t.* In the golden rule case, however, each cohort must leave neither wealth nor debt, since $C = Y_1$, and net transfers and credit must always integrate to zero for the population, so the integral can be taken to ω.

The aggregate wealth equations can be reexpressed in a suggestive way by going back to their original defining integrals. This is done for *W*; the calculations for *T* are similar:

$$W = b\int_0^{\omega} e^{-nx}\int_0^{x} e^{n(x-a)}p(a)[y_l(a)-c(a)]dadx = b\int_0^{\omega}\int_0^{x} e^{-na}p(a)[y_l(a)-c(a)]dadx .$$

$$W = b\int_0^{\omega}\int_a^{\omega} e^{-na}p(a)[y_l(a)-c(a)]dxda = b\int_0^{\omega}(\omega-x)e^{-nx}p(x)[y_l(x)-c(x)]dx .$$

The second line is obtained by changing the order of integration. Inspection of the last expression on the right shows that *b*ω is multiplied by (Y_1 - C), which under the golden rule assumption must be zero. The integrals involving the factor *x* can be seen to be the numerators of average ages, for which Y_1 or *C* would be the denominator. These observations lead to the appealingly simple result

$$W = bC(A_c - A_{y_1}) = c(A_c - A_{y_1}).$$

Here, A_c and A_{y1} are the ages at which the average dollar is consumed and earned in the stable population—conveniently referred to as the average ages of consuming and earning. This fundamental result is closely related to a similar result in Willis (1988) for a population with discrete age distribution and no intra-life span mortality.

The equation has an intuitive interpretation: Consider the case $n = 0$, and suppose that all earnings over the life-cycle, amounting to Y_1, were received at the average age of earning, A_{y1}. Similarly suppose that all life-cycle consumption, amounting to $C = Y_1$, occurs at age A_c. If $A_c > A_{y1}$, then every person in the population between age A_{y1} and A_c will hold an amount of wealth $C = Y_1$. Everyone else will have no wealth at all. The proportion of the population holding wealth will be

$$(A_c - A_{y_1})/e_0 = b(A_c - A_{y_1}) .$$

Therefore the wealth held by the average person will be

$$bC(A_c - A_{y_1}) = c(A_c - A_{y_1}) .$$

If $A_c < A_{y1}$, then a similar argument shows that this expression gives the average negative wealth, or debt. An alternative interpretation can be given in terms of the length of time the average dollar earned is held before being spent.

As for transfer wealth, note that because the present value of transfers must integrate to zero over the expected life-cycle, transfer wealth at age x is just the negative of the weighted integral of $\tau(a)$ up to age x. Let $\tau^+ = \tau^-$ be the average gross flow of transfers to or from individuals in the population. Then by a similar derivation, the per capita value of transfer wealth is given by

$$T = \tau^+(A_{\tau+} - A_{\tau-}) .$$

Although the flows of transfers made and received at any instant must sum to zero, transfer *wealth* is not generally zero, which distinguishes transfers sharply from private sector loans. Transfer wealth can be nonzero because society can obligate the as yet unborn to make (or receive) future transfers—transfers that show up only in the expected payments or receipts of *current* members of the population, but not correspondingly in the expectations of the unborn since they do not enter the integral.

Combining these results, we have

$$K = c(A_c - A_{y_1}) - \tau^+(A_{\tau+} - A_{\tau-}) .$$

The Accounting Framework: Economic Hypotheses and Interpretations

These results provide a coherent and comprehensive framework that can be used to express hypotheses in the economics literature pertaining to various aspects of age-distributed economic behavior. This is illustrated very briefly with a few examples.

Starret (1972:283) writes about models of this general sort: "Investment does not require waiting! ... since it is possible to distribute consumption so that everyone consumes before he earns, the effect of increased roundaboutness on increased waiting is eliminated. It is this peculiar divorce of investment from waiting that really lies behind the 'biological theory of interest.'" The basic identity $W = K + T$ expresses this peculiar divorce. Even if W is negative, indicating that "everyone consumes before he earns," so that there is no waiting, there may still be a positive K, provided only that T is sufficiently negative, that is, that output is sufficiently strongly reallocated to younger ages. I believe that this constellation was actually the typical case in high-mortality traditional societies.

Let T^F denote transfer wealth arising from familial transfers, T^G denote transfer wealth arising from public sector transfers, and T^D denote government debt. Then the identity derived above becomes

$K = W - T^F - T^G - T^D$.

Many economists, and most notably Modigliani (e.g., 1988), argue that the life-cycle saving motive, principally to provide for retirement, is the most important explanation for aggregate capital accumulation. In my notation, Modigliani argues that the magnitude of W largely accounts for the magnitude of K, in some sense. Other economists, most notably Kotlikoff and Summers (e.g., 1981 and 1988), argue that the desire to make transfers to children, and in particular the desire to make bequests, is the most important explanation for the level of K. In my notation, they argue that $-T^F$ largely accounts for K. In practice, this debate has sometimes taken the form of evaluating the ratio $-T^F/K$ which is taken to measure the importance of the intergenerational transfer motive, or the ratio $(W - T^G - T^D)/K$, which is taken to measure the importance of the life-cycle saving motive.[11] K

[11] There are, unfortunately, several notational differences. My K is their W. My W is their L. My T^F is their $-T^F$. So far as I can tell, they do not include governmental transfers in their accounting identity. If they did, then given their definition of transfer wealth, every age group would hold Social Security debt rather than positive wealth, and the society over all would hold Social Security transfer debt, since they define transfer wealth as the sum over cohorts of the accumulated net transfers received at each age. But at almost every age, cohorts will have paid more into the system than they have received from it, since payment precedes receipt.

sometimes is taken to be solely non-household sector, non-government sector capital, and at other times only government capital is excluded.

Calculating $(W - T^G - T^D)/K$, Kotlikoff and Summers (1981) find that it is perhaps as low as 0.2, leading them to conclude that familial intergenerational transfers must provide the main motive for capital accumulation in the United States. This is not inconsistent with my own calculations if K is restricted to the production sector and excludes household capital and public sector capital. However, that formulation obscures the relative magnitudes of the various components. For example, I find W to be nearly three times as large as $-T^F$. Indeed, since the life-cycle demand for wealth is met in good measure by holdings of public sector transfer wealth, T^G, which is nearly twice the size of $-T^F$, the comparison of $-T^F$ to K seems to me not to be very informative. An alternative comparison would be of $-T^F$ and W to $K + T^G + T^D$. In this comparison, W would appear to be three times as important as $-T^F$. However, as seems to be generally acknowledged, what is really relevant is the elasticity of K with respect to $-T^F$, for which these accounting identities provide no information.

Generational accounts (Auerbach et al., 1991; Kotlikoff, 1992) are calculations of age-specific public sector wealth, $T^G(x)$, excluding educational transfers, with particular attention to the implications of the changing form of taxation. Generational accounting does not generally assume the steady state, and indeed much of its interest derives from its ability to tell us who gains and who loses in transitional situations.

Another important issue is the effect of public sector transfer wealth, T^G, on K. Feldstein has argued that T^G is a close substitute for K and that therefore $\delta K/\delta T^G$ is a large negative number, perhaps -1 in the extreme case. If Social Security and Medicare, the most important components of T^G, were primarily a remedy for the improvidence of a population that failed to save in such a way as to achieve an optimal allocation of consumption over the life-cycle, then T^G might lead to more consumption at older ages and thereby raise W rather than diminishing saving earlier in life. In the extreme case, this would lead to $\partial K/\partial T^G = 0$. Another possibility, raised by Barro (1974), is that parents recognize that Social Security will require higher taxes from their children while delivering more income to them later in life. They may respond by making larger *inter vivos* transfers, or leaving larger bequests, so that K is unaffected and familial transfers change to offset governmental transfers. In the extreme case, $\partial K/\partial T^G = 0$ and $\partial T^F/\partial T^G = -1$. The accounting framework can be used to pose the hypotheses, but cannot say which is correct.

ECONOMIC CONSEQUENCES OF POPULATION AGING DUE TO SLOW GROWTH

Now that we have sketched the way in which various mechanisms are used to reallocate resources across age and/or time over the life-cycle, it is time to consider how changes in the population age distribution interact with these mechanisms to generate economic consequences. What are the costs of population aging? Is it possible that more rapid population growth, while reducing per capita consumption due to capital dilution, might nonetheless lead to higher life-cycle consumption? Here, I consider how the change in the population growth rate affects the present value of life-cycle consumption across golden rule steady states by differentiating the budget constraints developed above.

The Economic Rate of Growth Effect

When the growth rate, n, and interest rate, $r = n$, change across golden rule steady states, the relative weighting of dependents and earners in the population will change, and therefore the amount consumed at some or all ages must change or, alternatively, the amount worked at some or all ages must change. The changes at age x that are made to maintain the accounting identities when population growth rates change may be denoted $\partial c(x)/\partial n$ and $\partial y_1(x)/\partial n$.[12] The integral over all ages, x, of these changes must be such that they preserve the equality of C and Y_1 across golden rule steady states. Differentiating the golden rule identity with respect to $n = r$, while holding $p(x)$ fixed (and ignoring for the moment the effect on capital per worker) but letting the age profiles of earning and consumption vary as discussed above, we find

$$\int_0^{\omega} e^{-nx} p(x)[\partial c(x)/\partial n - \partial y_l(x)/\partial n]dx = C(A_c - A_{y_l})$$

if K is held fixed.

But the changed growth rate will also alter the amount of capital per worker, which will change the productivity of labor, and thereby change the earnings function and require additional adjustments. When this model is embedded in a Solow growth model[13] (Arthur and McNicoll, 1978; Lee,

[12] Holding survivorship constant and varying the growth rate in a closed population is equivalent to varying fertility.

[13] In a Solow (1956) growth model, output is produced under constant returns to scale, from inputs of capital and labor. For any given savings rate and population growth rate, the model converges to a steady state. For a given population growth rate, we can choose the savings rate that maximizes steady state per capita consumption. This is the "golden rule" steady state. which can be shown to have $r = n$ and $C = Y_1$. Across golden rule steady states, $dc/dn = -k$, where k is capital per capita.

1980; Willis, 1988), an additional term reflecting the effects of capital dilution across golden rule paths is added to the derivative:

$$\int_0^{\omega} e^{-nx} p(x)[\partial c(x)/\partial n - \partial y_l(x)/\partial n]dx = C(A_c - A_{y_l}) - K/b\,,$$

where K is the average amount of capital (or real wealth) per person. (This derivative, by ignoring the effect of population growth rate on the age distribution of capital stock, and hence on the rate of depreciation, may considerably overstate the role of capital dilution; see Blanchet, 1988.) But this is just $(W - K)/b$, or T/b, the per capita level of transfer wealth divided by the birth rate (see also Willis, 1988):

$$\int_0^{\omega} e^{-nx} p(x)[\partial c(x)/\partial n - \partial y_l(x)/\partial n]dx = T/b\,.$$

This result may be interpreted as follows. Consider two stable populations with different total fertility rates of two and three children, and the same life expectancy of 75. Their annual growth rates will differ by 0.0142. In the one with higher fertility, individuals may consume more over their life-cycles, or work less, such that the present value of all the expected changes equals 0.0142 x T/(1/75) = 1.065 x T, which could be positive or negative.[14] The specific changes in consumption and earnings at each age are not determined without additional behavioral assumptions—or, put differently, the result is very general and must hold across many different institutional contexts and preference functions. Consumption could be reduced by increased life-cycle savings, increased Social Security taxes, or increased familial transfers to the elderly. Labor earnings could be increased by additional hours of work each week or by postponing the age of retirement. The precise size of each such adjustment could be calculated by using this expression.

There are a number of points to make about this result. First, note that if parents plan to leave bequests to their children, this should be treated as a component of the net cost of children and included in the augmented expression just described. If, however, bequests are an accidental by-product of life-cycle saving and the uncertainty of age at death, then the analysis presented above is correct without additional modification. Although be

[14] A population with a total fertility rate of 2 and e_0 = 75 will be very nearly stationary. In a stationary population, the crude birth rate is just $1/e_0$, which is the figure I have used for b in this calculation.

quests were notationally finessed by viewing them as *inter vivos* transfers, the substance of the Modigliani-Kotlikoff/Summers debate has an important effect on the calculated effects of population aging.

If we wished to give a welfare interpretation to these calculations, we would have to take into account the utility parents receive from having the incremental children when n increases. For optimizing parents, the marginal utility from a child will equal the value of all the familial transfers that they plan to make to it, that is, T^F. Therefore, only the effects of changed age distribution on public sector transfers, T^G, will affect welfare (Lee and Lapkoff, 1988). Put differently, T^G, translated into per child units, constitutes an externality to childbearing.

From the point of view of the individual, these changes are responses to the changed interest rate, n, and to whatever changes in tax and transfer policies are made in order to keep the economy on the golden rule path when n changes. For example, to raise capital formation, the government could increase downward transfers by increasing funding of higher education and raising taxes accordingly. To reduce capital formation, the government could increase public sector pensions, while raising taxes accordingly. These actions would reduce T and raise T, respectively.

From the macro point of view, they are changes in response to the changed population age distribution. In order for the golden rule accounting identity to remain true, this quantity must equal the difference between the average ages of consumption and earning, less the capital/consumption ratio. For example, if the third life-cycle stage is very long and consumption is relatively high in old age relative to childhood, as is the case in most contemporary industrial populations, then A_c - A_{y1} will be positive, since the average age of consuming will be high. In this case, there are beneficial effects of a declining dependency burden that will tend to offset the negative effects of capital dilution if the population growth rate is higher. By contrast, if the mortality is very high and old age is seldom attained, then A_c - A_{y1} may be negative, with a young average age of consuming. In this case, both the dependency effect and the capital dilution effect work in the same direction.

In fact, it appears that in the United States in the 1980s, A_c -A_{y1} was about +4 years, on a household basis (Lee and Lapkoff, 1988), and similar results have been found for Japan and England (Ermisch, 1989). Evidently, the average household needs to hold positive wealth equal to about four times its average consumption or earnings in order to achieve the desired reallocation of income from younger to older ages.

Using the Mueller (1976) age profiles of consumption and earnings for a Third World agricultural population, together with a Coale-Demeny life table for a life expectancy of 20 years, and taking $n = 0$, we can also calculate A_c - A_{y1} for a hypothetical high-mortality traditional society. In contrast to the gap of +4 years for the United States, this calculation yields a gap of -5 years, indicating strong downward transfers from older to younger people. This is not surprising, given that old age occupies only 3 percent of the average life-cycle, while childhood occupies 36 percent. In such a society, there is aggregate life-cycle debt rather than wealth because the average member of the population has received transfers from his or her parents that have not yet been repaid by making equivalent transfers to their own children.

If we made some assumptions about the specific forms of life-cycle utility function governing the choice of consumption at each age and labor supply at each age, the functional dependence of $y_1(x)$ and $c(x)$ on the population growth rate could be calculated explicitly. But the characterization of the necessary adjustments to consumption and earnings given above is very general and must hold for any behavioral assumptions we might choose to add to this model.

Samuelson (1975) suggested that because more rapid growth lowered life-cycle consumption through capital dilution, but also raised it by reducing the old age dependency burden, there might be an optimal rate of population growth at which the two effects were just offsetting. He called such an optimal rate of population growth for an economy with optimal saving, the "goldenest golden rule path." From the analysis above, we can conclude that when $T = 0$ on a golden rule path so that individuals willingly hold exactly the amount of capital that is socially optimal in the golden rule sense, then the population growth rate is optimal and the path is the goldenest golden rule.

Samuelson (1975) was initially mistaken about second-order conditions, and under his assumption the optimal growth rate was actually infinitely slow or infinitely rapid (Deardorff, 1976; Samuelson, 1976). Kim and Willis (1982) consider the more general case in which the life-cycle incorporates both old age and childhood dependency stages. They note that consumption will have higher variance across age than earnings, since earnings are all in the middle age group, whereas consumption is spread out across all ages. This fact, and some other weak conditions, are sufficient to guarantee that some finite growth rate will be optimal. Arthur and McNicoll (1978) also made an important contribution to this controversy.

The Impact of Aging Due to Slow Growth on Transfer Systems

Regardless of whether the economy is golden rule or follows some other steady-state path with r different from n, a change in the population growth rate will entail adjustments in all transfer systems, as indicated by the following equation:

$$\int_0^{\omega} e^{-nx} p(x)[\partial\tau^+(x)/\partial n - \partial\tau^-(x)/\partial n]dx = \tau^+(A_{\tau^+} - A_{\tau^-})/b\,.$$

This equation applies to the aggregate of all transfer systems, but it also applies to each one individually. The interpretation is by now familiar: if, on average, payments are made into the system before benefits are received, then a more rapidly growing, younger population will be able either to increase the benefits at some or all ages or to reduce the payments.

For example, consider total governmental transfers in the United States, including state, local, and federal. About 3.8 dollars is spent on each elderly person for each dollar spent per child (O'Higgins, 1988). Furthermore, the steady-state age distribution based on current rates (replacement level fertility, and a life expectancy of 75 years) will be quite old. Consequently, based on 1987 Consumer Expenditure Survey data (Lee, in press, b),

$$A^G_{\tau+} - A^G_{\tau-} = 12\,,$$

where the *G* indicates governmental transfers (the observational unit is households by age of respondent, but the age gap from individual data is similar). The average annual inflow per household was $6,800, which is about $2,600 per capita. Governmental transfer wealth per capita, therefore, was about 12(2,600) = $31,200 in 1987. If population growth were 1 percent per year more rapid, transfer payments could be greater by $312 per year, or taxes could be less by this amount, per person; $312 is roughly 2.5 percent of per capita consumption in 1987. The annual flow of $312 can be converted to a life-cycle total by multiplying by 1 divided by the household equivalent of the crude birth rate—in this case, multiplying by 28.5, which is the expected years of household headship in the stationary population.

One should not think, however, that more rapid population growth always relaxes governmental transfer system budget constraints. The results just given for the United States are probably fairly typical for modern industrial countries, but they are quite different from those for most Third World countries. Figure 2-9, for example, shows the age profiles of government taxes and transfers for India in 1981 (see Lee, 1991), weighted by the stable population age distribution. For India,

$$A^G_{\tau+} - A^G_{\tau-}$$

turns out to be -11 years, so that transfers flow downwards in India about as much as they flow upwards in the United States. This result is typical of the seven Third World countries I have studied, the only apparent exception being the rare Third World countries with strong public sector pension programs, such as Brazil (Lee and Miller, 1990).

It is also interesting to look in more detail at the way in which slower population growth would affect different transfer subsystems in the United States. Table 2-2 shows such a breakdown, based on the household accounting framework.

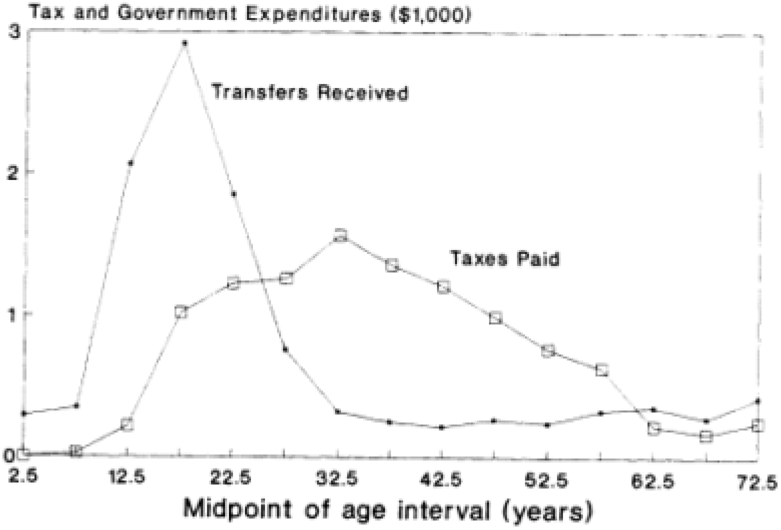

Figure 2-9
Indian public expenditures on health, education and pensions, and tax payments, 1981, weighted by stable population.
SOURCE: Based on data in Lee (1991).

The effects shown in the second to last column are calculated on a per household per year basis. To convert these into lifetime costs or gains per individual, the last column shows them multiplied by the expected number of years of household headship per individual, which is about 28.5. Bequests are treated here as if they are simply another cost of children, an aspect of expenditure on child "quality." But it is also possible that they are the unintended by-product of unexpectedly early death or of saving more than is on average necessary for retirement. In this case, the saving on bequests attributed in the table to slower growth is spurious.

Overall, it appears that on an individual accounting basis, the upward transfers through the public sector roughly offset the downward transfers within the family, so the net effect of slower growth is small. However, strong pressures obviously emerge in federal transfer programs, where households must either pay about $1,000 more per year in taxes ($690 + $350), receive correspondingly less annually in benefits, or some combination of the two.

TABLE 2-2 Annual Costs or Gains per Household of 0.01 per Year Slower Population Growth, Arising Through Transfer Subsystems in the United States

Transfer Channel	$A_{\tau+}$, Average Age of Receiving Transfer (years)	$A_{\tau-}$, Average Age of Making Transfer (years)	$\tau+$, Average Annual Inflow per Household (dollars)	*T*, Average Transfer Wealth Held in this Form (dollars)	Average Annual Cost per Household of dn = 0.01 or of 0.5 Lower TFR (dollars)	Lifetime Cost or Gain for an Individual (dollars); (28.5 times previous column)
Social Security	71.7	41.2	2,270	69,000	690	19,700
AFDC	36	45	91	800	-8	230
Education	39.3	46.7	2,342	-17,000	-170	-4,800
Total health	61.6	42.8	1,862	35,000	350	10,000
Inter vivos gifts	38	53	370	-5,500	-55	-1,600
Bequests	52	77	1,750	-44,000	-440	-12,500
Child rearing[a]	10.6	39.3	2,820	-81,000	-405	-11,542
College costs[a]	20	48	215	-6,000	-30	-855

NOTE: AFDC = Aid For Dependent Children; TFR = total fertility rate.

[a] These items are intrahousehold transfers and should not be included in the total transfers when using the household framework, only when using the individual framework as in the last column. The corresponding numbers are in italics. In the household-accounting framework, these transfers to household dependents should already be reflected in the age profiles of household expenditures. Counting them again separately would be double counting. In the last two columns, the transfers per child have been multiplied by 0.5, the change in fertility associated with a change of 0.01 in the population growth rate in the neighborhood of $n = 0$.

SOURCE: Calculations for Social Security, AFDC, gifts, and child rearing are based on an analysis of data from Bureau of Labor Statistics (1987). College costs and education are based on aggregate data in Bureau of the Census (1990). Bequest flows were calculated from Modigliani (1988; see Lee, in press, b).

ECONOMIC CONSEQUENCES OF POPULATION AGING DUE TO LOW MORTALITY

Mortality Change and Life-Cycle Planning

"Individual aging" refers, in common language, to the increasing age of some person. Here, however, I use it to refer to the changing shape of the average life-cycle, when life expectancy rises so that the expected number of person-years lived at older ages increases, as shown in the figures earlier. When individual aging occurs, the life-cycle budget constraint above will no longer hold for the initial age profiles of earning, consumption, and transfers. In particular, if the expected numbers of person-years lived in the elderly life-cycle stage increases relative to the number of person-years lived in the working ages, then either consumption will have to be reduced at some or all ages, or earnings will have to be increased. For this reason, we can view the age profiles of earning and consumption as functions, at every age, of the general level of mortality, indexed by *i* as above, just as we have viewed them earlier as functions of *n*.

Mortality Decline, Consumption, and Earning: The Economic Life-Cycle Effect

The basic strategy is to differentiate the golden rule life-cycle budget constraint with respect to the mortality level and set the derivative equal to zero. For the present, we hold *n* constant and assume that labor productivity is unaffected by changes in the amount of capital per worker; later we allow these to vary with *i*.

In the golden rule case, we have

$$\int_0^{\omega} e^{-nx} p(x)[\partial c(x)/\partial i - \partial y_l(x)/\partial i]dx = \int_0^{\omega} e^{-nx}[\partial p(x)/\partial i][y_l(x) - c(x)]/dx$$

holding *n* fixed.

The integral on the right is the discounted sum, over all ages, of the changes in person-years lived at each age multiplied by the surplus or deficit of earnings over consumption at each age. Evidently, if person-years lived increase at an age in which more is earned than is produced, the life-cycle budget constraint will be relaxed; if person-years lived increase at an age in which more is consumed than is produced, such as childhood or old age, then the budget constraint will be tightened. The integral gives the net effect of all these surpluses and deficits and may be positive or negative. This integral is the present value, at birth, of all the adjustments that must be made when life expectancy rises by 1 year.

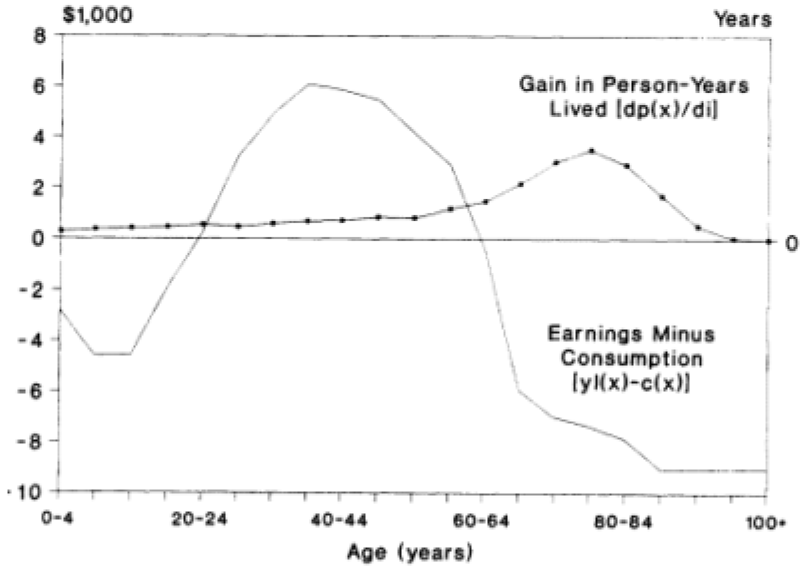

Figure 2-10
Person-years of life gained for 1-year increase in life expectancy versus labor earnings minus consumption, U.S. data, 1985. SOURCE: The distribution of person-years gained is based on recent Swedish life tables. The data on earnings minus consumption are taken from Lee and Lapkoff (1988), based on the 1985 Consumer Expenditure Survey.

It is instructive to plot $\partial p(x)/\partial i$ against $y_1(x)$ $-c(x)$ for actual data. Figure 2-10 does this for U.S. data. It is striking that the greater part of the gains in person-years lived occurs at ages for which consumption vastly exceeds earning. Indeed, 66 percent of the gains occur at age 65 or over.[15] Computing the population-weighted integral as described by the right side of the equation, and dividing by the present value of life-cycle consumption so that both sides are expressed as proportions, yields a value of -0.009, or nearly -1 percent. The interpretation is that a 1-year increase in life expectancy requires adjustments to life-cycle consumption or labor earnings equal to 0.9 percent of their present value at birth. These adjustments could take the form of a 0.9 percent reduction in consumption at every age; an increase in labor supply by 0.9 percent at every age, say from 40 hours per week to 40.36 hours per week; or a postponement of retirement by five months from

[15] For the Swedish mortality on which this figure is based.

age 65 (if the productivity at age 65 is assumed to equal the life-cycle average, and the rate of population growth is zero; if productivity is below average, or the growth rate is positive, then retirement would have to be postponed longer).[16]

I call this the life-cycle effect, or individual aging effect, of declining mortality because it reflects the simple need to provide for more years of life, in this case life lived in retirement.

One should not think, however, that mortality decline is necessarily costly in this way. A similar calculation can be carried out for a hypothetical high-mortality population with initial life expectancy of 20 years, and earning and consumption profiles as reported in Mueller (1976), intended to be representative of Third World agricultural populations. In this case, the life-cycle effect is actually positive! Person-years of life gained are predominantly in the working ages, as can be confirmed by reference to Figure 2-5, which shows that at a life expectancy of 20, 69 percent of the gain accrues to the ages 15-64.

Mortality Decline and Transfers

There is a corresponding equation constraining adjustments to the transfer system, which holds not only for the golden rule case, but for the general case as well:

$$\int_0^{\omega} e^{-nx} p(x)[\partial\tau(x)/\partial i]dx = -\int_0^{\omega} e^{-nx}[\partial p(x)/\partial i]\tau(x)dx$$

for fixed *n*.

Figure 2-11 shows the information needed to make this calculation for Social Security. The integral equals about $3,200 over an individual life-cycle. To put this on an annual per capita basis, we can simply multiply by *b,* which yields $43 per year. The interpretation is similar to previous ones. When person-years are gained at ages that, on net, receive transfers, this is costly. The integral of gains and losses on the right must be balanced by adjustments to age-specific transfer flows on the left.

The effect of mortality change on health costs cannot be treated this simply, however. An appropriate analysis must treat separately the health costs of those who survive and the health costs of those who die. Those who die impose the heavy costs of a terminal illness. When mortality

[16] If the population growth rate is positive, then earnings at older ages are more heavily discounted over the life-cycle (or older people make up a smaller share of the population in a cross-sectional interpretation), and therefore retirement ages would have to rise by more. Lower survival to old age has a similar effect.

changes, the distribution of deaths by age changes, and hence the age profiles of health costs themselves change. This can all be handled in a straightforward way, but is not done here.

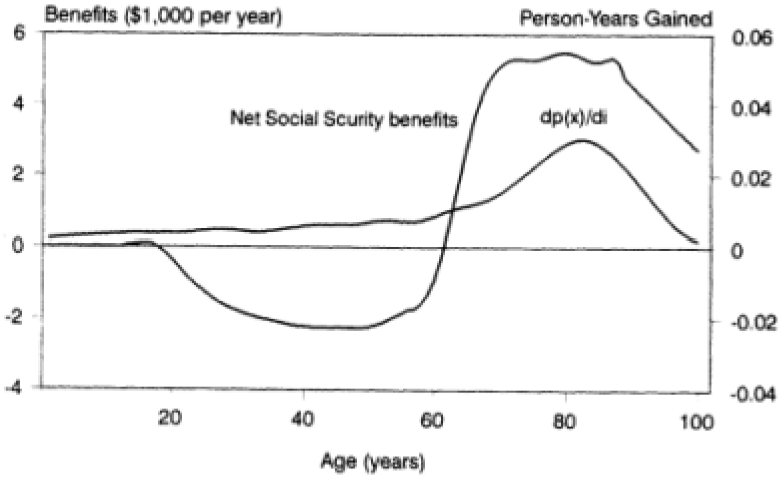

Figure 2-11
Annual net Social Security benefits and person-years of life gained (for a gain of 1 year in life expectancy) by age of individual.
SOURCE: Tax and benefit data calculated from 1987 U.S. Consumer Expenditure Survey. Mortality data calculated from recent Swedish life tables.

Mortality Decline and the Rate of Growth Effect

The derivatives above hold the population growth rate fixed. In practice, as discussed earlier, mortality decline leads to more rapid population growth, because more female births survive to the reproductive ages. The full derivative is as follows:

$$\int_0^\omega e^{-nx} p(x)[\partial c(x)/\partial i - \partial y_l(x)/\partial i]dx =$$

$$\left(\frac{\partial n}{\partial i}\right)[(A_c - A_{y_l})C - K/b] + \int_0^\omega e^{-nx}\frac{\partial p(x)}{\delta i}[y_l(x) - c(x)]dx\,.$$

$$\int_0^{\omega} e^{-nx} p(x)[\partial c(x)/\partial i - \partial y_l(x)/\partial i]dx = \left(\frac{\partial n}{\partial i}\right)[T/b] + \int_0^{\omega} e^{-nx} \frac{\partial p(x)}{\partial i}[y_l(x) - c(x)]dx .$$

What is added here is the factor $\partial n/\partial i$ which is multiplied by the rate of growth effect discussed earlier and has been shown to equal transfer wealth, T/b. We have seen earlier that $\partial n/\partial i$ is close to zero in low-mortality populations, but that it is substantial in high-mortality settings. In low-mortality settings such as the United States, therefore, the effect of mortality decline is essentially equal to the life-cycle, or individual aging, effect: people live longer, and their additional years are years of leisure. They must either consume less at each age or work longer in order to pay for the gift of longer life. We have seen that each additional year of life expectancy requires a reduction in consumption, or an increase in labor supply, of about 1 percent.

In high-mortality settings, $\partial n/\partial i$ is substantial, so that mortality decline makes populations younger. Because transfers are downwards in such populations, a younger population is costly. However, because there is little capital in such societies, capital dilution is presumably relatively unimportant. (Increased pressure on fixed resources probably is important, but is not included in this analysis.) Finally, the life-cycle effect is relatively small and positive, since mortality decline adds years of life mainly during the working years. The net effect is that mortality decline in both high-mortality and low-mortality settings has similar consequences, but for very different reasons: a 1-year gain in life expectancy entails a 1- percent reduction in the present value of consumption or a corresponding increase in earnings.

We see, then, that when mortality declines in high-mortality settings, the rate of growth effect dominates. Higher rates of return are earned on life-cycle wealth, which is held mainly in the form of transfer wealth. But since net allocational flows are downwards by age, such populations hold net transfer debt, and a higher rate of return is therefore costly and leads to reduced life-cycle consumption. When mortality declines in low-mortality settings, however, there is very little effect on the rate of growth, so the life-cycle effect dominates. The rate of return to life-cycle wealth is unchanged, but individuals must provide for more years of retirement, which is costly in terms of forgone consumption or leisure earlier in the life-cycle. In the special and historically inaccurate case of a neutral mortality decline, in which the absolute decline in the force of mortality at every age is equal, the rate of growth effect on the age distribution exactly offsets the life-cycle effect. Longer years of retirement could be paid for exactly by the increased rate of return on life-cycle wealth, requiring no readjustment of life-cycle consumption or earning profiles—if we ignore the effect of capital dilution.

The results of this section can be compared to those of Kotlikoff (1989:359), who reaches an apparently very different conclusion: "... increasing the length of life, including productive life, appears to permit a higher level of consumption in every year that an individual is alive." The principal difference, I believe, lies in Kotlikoff's assumption that labor supply increases at some ages over the life-cycle; I treat this as a costly reduction in leisure.

CONCLUSION: RESEARCH DIRECTIONS

This chapter has developed an economic-demographic age accounting framework with strong links to formal demography, as well as links to various models and themes in economics. These economic links include overlapping generations, optimal population growth, life-cycle saving, the bequest motive, generational accounting, and private responses to public transfer programs. I believe that further development of this interface of formal demography and macroeconomics holds promise for theory, measurement, empirical work, and policy-oriented research. Research needs can be divided into empirical applications of the basic framework, on the one hand, and further development of the accounting and analytic framework, on the other.

Empirical Applications

The framework described here can be used to organize, summarize, and interpret data on transfer systems and the life-cycle. As long as we use synthetic cohort methods, which assume that cohort profiles can be constructed from cross sections, the data necessary to implement the framework appear to be widely available in both developed and Third World populations. Because the analysis requires only aggregate age profiles rather than individual data, information can be drawn from differing sources and pooled, with a basic household expenditure survey providing much of what is needed. Data on bequests are an important exception, and for Third World populations, it may be necessary to develop measures of within-household transfers. More experience with application of the framework will indicate whether currently available data are adequate. If we abandon the synthetic cohort assumption, data requirements become very severe, because it is then necessary to reconstruct the life histories of each cohort. Some of the work by Kotlikoff and his collaborators makes only partial synthetic cohort, steady-state assumptions (Kotlikoff and Summers, 1981; Auerbach et al., 1991).[17]

[17] For example, Kotlikoff and Summers (1981) assume that the shapes of the age profiles of labor earnings and consumption are fixed, while allowing the levels of the profiles to vary by historical period based on estimated national aggregates for labor income and consumption. This is a partial synthetic cohort assumption.

One particularly promising use of the framework would be to shape and inform the development of age-based national accounts, continuing the work begun by generational accounting (Auerbach et al., 1991). Comparative cross-cultural and historical estimation also appears possible and should provide an interesting view of the transition from familial to public transfer systems as the welfare state develops, and perhaps also afford some insights into how the growth of public sector transfers affects life-cycle consumption profiles and capital accumulation. Some aspects of the resource flows from one ethnic group to another can be investigated within this framework; for example, do transfers flow from younger nonwhite populations to older white populations in the United States? It would also be very interesting to incorporate immigration, because the transfer patterns of subpopulations arriving as young adults would be quite different. There is a literature on the effect of migration on population age distribution (e.g. Schmertmann, 1992). Similarly, it may be possible to address gender issues. To do so properly would require introducing time use into the accounts, so as to treat explicitly the productive use of home time. Most of these extensions would require further methodological research.

Methodological Research

Although the basic framework is quite general, its implementation here is confined to a doubly special case: first, to steady states, and second, to golden rule economies with $r = n$. For calculations of the various forms of wealth, it is a simple matter to relax the golden rule assumption. However, to analyze the comparative statics of aging without the golden rule assumption would require making additional behavioral assumptions in order to determine $\partial r/\partial n$, for example, by specifying a life-cycle utility function as in Tobin (1967). Serious policy-oriented work requires relaxation of the steady-state assumption, so that transitional phases can be considered. There are two distinct aspects of the steady-state assumption. The first is the assumption that age profiles are changing only at a constant exponential rate, so that synthetic cohort estimation of the profiles is possible from a single cross section. Relaxing this assumption would impose very heavy demands for detailed longitudinal data over many decades. The second is that the population and economy are in steady state; this assumption is difficult to relax analytically, but it can in principle be handled by appropriate macrosimulation, elaborating on the methods used by Auerbach and Kotlikoff (1987).

There are a number of other issues that need to be resolved, some straightforward and some more difficult. Both the individual life-cycle framework and the household life-cycle framework require attention to conceptual as well as measurement issues. Education should be incorporated as a form of capital formation. Mortality change should be modeled in such a way that morbidity and labor efficiency change at the same time. Bequests and terminal illnesses should be made to depend not on age-group membership, but rather on age at death.

Behavioral Theory

This chapter has primarily addressed questions of accounting and has paid scant attention to behavioral issues. But there are important related research literatures on why people make familial transfers, on the rationale for public sector transfer systems (Becker and Murphy, 1988), and on the relations between public sector and familial transfers, as discussed earlier. There is also an important literature on the relation of familial and public transfer systems to fertility behavior (Caldwell, 1982; Willis, 1980, 1987). Advances in the conceptualization and description of transfer systems may also inform and stimulate further work on these important issues.

Although a great deal of work evidently remains to be done, the time is ripe for a synthesis of work carried out over the past three decades by formal demographers, economic demographers, and economists working on age-distributed macroeconomic models.

APPENDIX: HOUSEHOLDS

As shown earlier, in a stable population the proportion of people age x is $be^{-nx}\, p(x)$. Let $h(x)$ be the household headship rate at age x. The age distribution of household heads will then be $b^h\, e^{-nx}\, p(x)h(x)$, where b^h is the birth rate for households, given by

$$b^h = 1/(\int_0^\omega e^{-nx}\, p(x)h(x)dx)\,.$$

This could be viewed as 1 divided by the discounted expected years of household headship over the life-cycle. The undiscounted expected number of years of headship is simply

$$e^h(x) = \int_0^\omega p(x)h(x)dx\,.$$

which for the United States in 1987 was about 28.5 years. The average headship rate, h, is given by the integral over all ages of the stable age distribution for individuals in the population, weighted by $h(x)$.

Adult individuals often move through a succession of households as they age over the life-cycle. This does not cause problems for the accounting of budgetary flows. It does cause problems, however, for the account ing of stocks. The approach taken here is to use household headship rates to translate the household level flows into average pseudoindividual flows by multiplying by headship rates. Then these pseudoindividual flows are cumulated to get stocks, calculated per original member of the birth cohort. These stocks can then be reexpressed on a per household basis, if desired, or left at the individual level. For example, by letting the superscripts *h* and *i* denote household and individual flows, the equation for cumulation of life-cycle wealth would be

$$W^i(x) = \int_0^\omega e^{n(x-a)} p(a)h(a)[y_l^h(a) - c^h(a)]da .$$

To find *W* we would weight this by the size of individual birth cohorts as in the main text. Then if desired we could calculate the aggregate life-cycle wealth per household by dividing this individual measure by the aggregate household headship rate.

Unfortunately, these analytic expressions gloss over two serious complications. First, not all adults in the household need be the same age. When adults of very different ages are grouped together in households, as is sometimes the case, the age profiles for households will be far less informative about the life-cycle profiles of individuals—and it is ultimately individuals in whom we are interested. In many data sets, women will rarely be designated head if a male is present, so female ages will be systematically misrepresented by these procedures. The kind of flipping back and forth between accounts for households and for individuals that was just done for wealth accounting may then be incorrect and give misleading results. This problem will be particularly acute in Third World settings. Second, household headship is typically not distributed randomly across individuals of a given age. Instead, it may be that household headship is associated with economic variables of interest, such as labor earnings, consumption, or receipt of transfers. In this case, observing the economic flows into and out of households headed by a fraction of the population at some age, and then implicitly allocating a share of those flows to all people at that age, will be misleading.

One way to lessen the distortions arising in these ways is to take the ages of all adults in the household into account. A simple way to do this would be to randomly choose one of the adult household members to designated the head, or better, the household reference person. A more efficient way would be to allocate a share of the household resources to each adult, keeping track of their individual ages. Such procedures can eliminate much of the bias in working at the household level.

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3

Retirement and Labor Force Behavior of the Elderly

Joseph F. Quinn and Richard V. Burkhauser

INTRODUCTION

The transition from work to retirement has long been a major concern of public policy analysts and practitioners. All modern industrialized countries and many developing countries have created policies to mitigate the risk of income loss due to retirement. But in so doing, they have fundamentally altered the reward structure of work and retirement across the life-cycle. The resulting changes in the labor force behavior of older people have been dramatic. In this chapter, we review recent economic research on these issues and outline the areas we think need additional research. We do so from the perspective of the United States, while recognizing that the labor force trends found here are not unique and that cross-national comparisons of public policy and its consequences are useful inputs for understanding and developing domestic policy.

Cross-national comparisons are appropriate because most industrialized countries have instituted retirement policies that discourage work at older ages. In the last decade, these policies have begun to change. In the United States, for instance, recent legislation has outlawed mandatory retirement, banned the cessation of service year credits in pension calculations after a particular age, and increased the Social Security credit for delayed retirement after the age of 65. One intent of these changes is to make the

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retirement system age-neutral with respect to work; that is, to end the age-specific penalties for work beyond specified ages that are imbedded in our current retirement system so that the lifetime value of retirement benefits will not depend on the age at which they are first claimed.

But a more fundamental force is likely to affect retirement policy in the future—the aging of postwar baby boomers. The United States and Germany have already enacted changes in their primary retirement insurance systems that will raise the age of normal retirement early next century. A review of past policies will be useful as we lay the groundwork for retirement policy in the twenty-first century.

Our discussion of retirement policy extends beyond the Social Security retirement program. In most countries, and certainly in the United States, Social Security disability programs provide a bridge to retirement for some of those too young to qualify for retirement benefits. This protection raises the same economic incentive issues that are the focus of much of the retirement research. Hence, in looking at labor force participation at older ages, we must look at the full impact of the social welfare system on work decisions.

Retirement policy extends well beyond government transfer programs. Private contracts between employers and employees can also alter the incentives to work at older ages even when explicit wage rates do not change. Employer pension plans and health benefits also influence the retirement patterns of older workers. Government attempts to alter these contracts provide another topic for public policy analysis.

Below, we first document some worldwide trends in labor force participation at older ages and review the literature that has attempted to explain them. We find that although most workers have a choice with respect to retirement age, the choice is constrained by personal health factors, government retirement and disability policies, and employer pension plans. The major debates in the literature are not about the presence of such constraints but rather about the magnitude of their impacts. We end by suggesting how labor force behavior may change as new cohorts of older workers emerge in the next century, and outlining the research and data that will be needed to track this behavior.

THE LABOR SUPPLY OF THE ELDERLY

Labor Force Participation

The United States

The retirement trend of older Americans over the last several decades is dramatic. A simple measure is the labor force participation rate—the ratio of those employed (full-time or part-time) or actively searching for work to the civilian noninstitutionalized population. Figure 3-1 shows U.S. participation rates from 1964 through 1992, for cohorts of men aged 45-49 through 70+. For men aged 60-64, which includes the earliest age of eligibility for Social Security retirement benefits (62), participation has dropped nearly a third, from 80 to 56 percent. For men aged 65-69, the decrease is about 40 percent, and for those 70 and over, the participation rate has dropped one-half. The trends are less striking for the younger groups, but even those aged *55-59* have dropped 10 percentage points, with more modest declines for those aged 45-54.

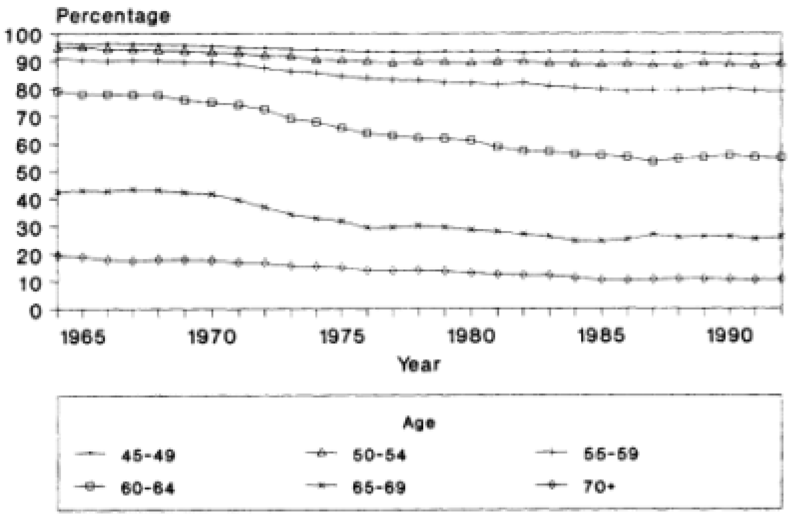


Figure 3-1
United States male labor force participation rates by age, 1964-1992.
SOURCE: Bureau of Labor Statistics, *Employment and Earnings,* January issues.

For women, the trends are less precipitous, because two offsetting phenomena are at work. People are retiring earlier, but women, especially married women, are more likely to work than previously. For the oldest female cohorts (aged 60 and older), the resultant trends are flat (see Figure 3-2); for the younger groups, the latter dominates, and participation rates are on the rise.

The U.S. Department of Labor gathers some labor force data by individual ages. Figure 3-3 shows participation rates for men aged 60-65, which include key ages for Social Security (62 and 65) and for many employer pensions (age 60). The long-run trend can be seen in two ways—the decline for each age over time and the change in the most prominent single-

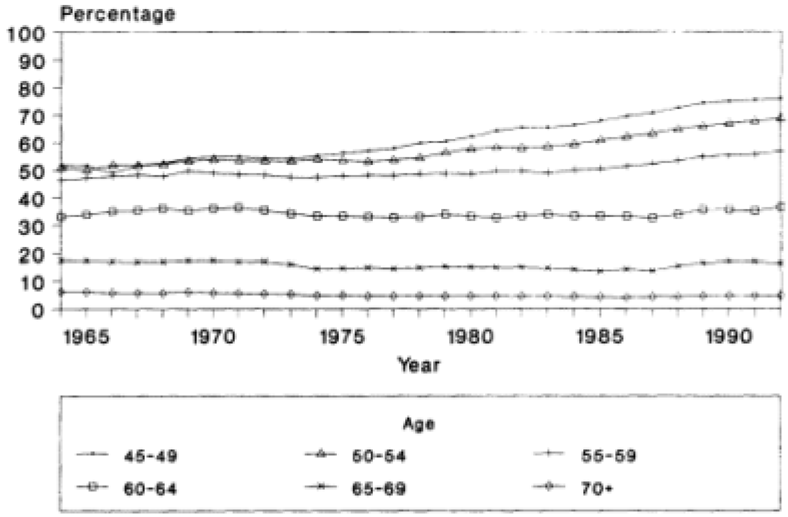


Figure 3-2
United States female labor force participation rates by age, 1964-1992.
SOURCE: Bureau of Labor Statistics, *Employment and Earnings,* January issues.

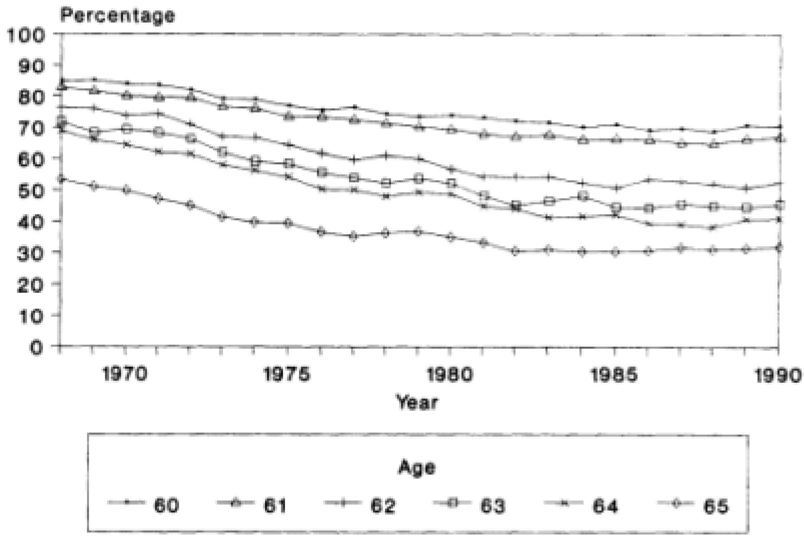


Figure 3-3
United States male labor force participation rates, ages 60-65, 1964-1990.
SOURCE: Unpublished data, U.S. Department of Labor.

year gap. In 1968, the largest behavioral change occurred between ages 64 and 65. Now, the biggest change is between ages 61 and 62. A gap at age 65 remains, but much of the labor force departure has already occurred.

The most recent data suggest that the trend toward earlier retirement in the United States may have stopped or even reversed. For all of the age categories of men above age 50 in Figure 3-1, participation rates over the past 5 years are virtually unchanged. For 11 of the 16 individual ages between 55 and 70 (and for 8 of 10 ages over 60), male participation rates were actually higher in 1990 than in 1985.

In summary, men are leaving the labor force much earlier than they were even two decades ago, but there has been little change in the past few years. (As we see below, however, the trends may be continuing still, but in another guise—reduced hours of those employed.) Women's retirement trends are being offset by a rising tide of female labor force participation in general.

Other Organisation for Economic Co-operation and Development (OECD) Nations

The early retirement trend can be seen in other industrialized nations as well. The participation rates differ by country, as do the magnitudes of the declines, but the general pattern is the same—people are retiring earlier than they used to.

Table 3-1 shows the employment-to-population ratio for 16 OECD countries, from 1966 to 1990, for men aged 55 and over.[1] The current figures range from 11 percent in Italy to 60 percent in Japan, with most countries in the 30-40 percent range. But every one of these countries except Japan has seen a significant fall. The U.S. decline (about 30% over these 24 years) is typical.

Figure 3-4 shows employment to population ratios by age (55-59, 60-64, and 65+) for men in eight selected OECD countries in 1975, 1980, 1985, and 1989 (1987 for West Germany). For the youngest group, these ratios in 1989 ranged from about two-thirds in the Netherlands to more than 90 percent in Japan. Over the past 15 years, the declines ranged from 13 to 15 points (Australia, France, the Netherlands, and the United Kingdom) to less than 1 point (Germany and Japan).

Employment rates are substantially lower for the cohort of men aged 60-64—from around 20 (Japan and Sweden) to 25 (Australia, Sweden, United

[1] The employment-to-population ratio is close to the labor force participation rate. The latter includes those unemployed (not employed and actively searching for work) in the numerator and therefore is slightly larger. But official unemployment rates tend to be low for the aged, so the differences are small. The long-term stories told by both measures are identical.

Kingdom, and United States) to more than 40 points lower (France, Germany, and the Netherlands)—than they are for men aged 55-59. The rates range from a low of about one-quarter (France and the Netherlands) to more than 70 percent in Japan. The declines since 1975 have also varied greatly, from about 10 percent in Japan, Sweden, and the United States to more than 40 percent in the Netherlands.

With the exception of the Japanese, market work is now rare among men aged 65 and over. In Japan, more than a third of these men still work, and in Sweden and the United States, one in six or one in seven do. But in the other countries shown, fewer than 10 percent are employed. In France, Germany, and the Netherlands, the figure is closer to 5 percent. Compared to men aged 60-64, several of the cohort drops are precipitous—more than 40 percentage points in Australia, Sweden, and the United Kingdom. A recent study by the OECD (1992:Chapter 5) suggests that these early retirement trends are due to various combinations of explicit incentives in national social security and disability programs, occupational pensions, and collective bargaining agreements.

Several summary points emerge. In all of these countries, male employment rates drop dramatically between the ages of 55-59, when the vast majority of men are still working, and 65 plus, when work is the exception, not the rule. The age at which the decline occurs varies. Some countries have huge participation declines at ages 60-64 (France, Germany, and the Netherlands—all more than 40-point drops), and the others have a large decline at ages 65 and over (Australia, Japan, Sweden, the United Kingdom, and the United States—all more than 35-point drops). Second, the trend toward earlier retirement is observed everywhere, but in many countries like the United States, it has tapered off in recent years. Third, U.S. participation rates are typical for men aged 55-59 and 60-64, but relatively high for men 65 and over. Finally, Japan stands out as an exception on work at older ages, with the highest rates for all three age cohorts; it is the only one of these countries in which one-third of men over 65 continue to work.

The trends for women are more varied. Table 3-2 shows employment to population ratios for women aged 55 and over in the same 16 OECD countries. In some (such as Canada, Australia, Italy, Japan, and the United States), there has been little change over the past 20 years. Others (Finland, France, West Germany, Spain, and the United Kingdom) have had the same declines observed with men. Only in Sweden has older women's employment increased steadily.

Women also show significant labor force withdrawal as they age, although less so in the United States than in most of these other countries. Only in Canada, Japan, Norway, Sweden, and the United States are more than one-third of the women still working at ages 60-64 (not shown); for women aged 65 and over, participation rates are in the single digits for all 16 countries, except Norway and Japan.

TABLE 3-1 The Employment-to-Population Ratio for Men Aged 55 and Over (in percent)

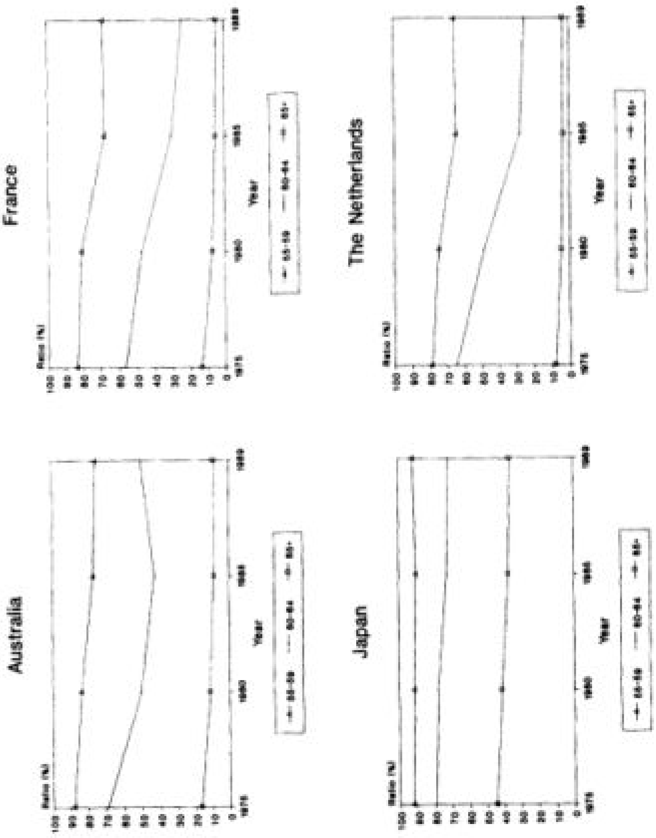
Year	Australia	Canada	Finland	France	Germany	Ireland	Italy	Japan
1966	—	42.6	60.3	—	—	69.7	17.7	—
1967	57.0	42.8	59.6	—	53.4	—	28.5	—
1968	56.8	42.5	54.7	58.4	52.5	—	27.6	70.4
1969	56.1	42.8	52.9	57.5	47.3	—	0.0	70.1
1970	56.3	52.2	61.3	54.2	48.6	—	25.3	68.5
1971	55.5	50.6	59.3	52.3	45.1	67.3	24.7	68.0
1972	55.1	49.6	55.8	50.2	41.9	—	21.8	66.7
1973	54.0	49.0	54.5	47.7	39.9	—	21.2	66.7
1974	51.4	48.5	54.5	46.0	36.5	—	21.7	65.5
1975	48.7	48.4	50.2	44.5	33.7	57.5	21.2	63.9
1976	46.4	46.2	44.3	43.4	32.3	—	19.8	62.6
1977	45.2	45.3	40.8	43.4	31.4	55.6	21.6	61.3
1978	42.2	45.0	38.3	42.5	30.3	—	20.1	60.8
1979	40.8	45.2	38.3	42.3	29.8	54.6	18.2	60.6
1980	40.0	44.7	39.0	41.7	29.9	—	18.7	61.0
1981	38.9	43.7	38.7	40.8	29.7	52.5	18.2	60.8
1982	36.8	41.9	38.8	38.5	29.5	—	14.8	60.4
1983	33.9	40.5	36.0	35.2	29.1	49.1	17.5	59.9
1984	34.1	39.7	35.1	33.9	28.2	47.6	18.5	59.4
1985	33.1	38.9	34.3	33.1	28.0	44.7	18.3	58.9
1986	33.2	37.9	33.9	32.0	28.5	45.7	18.1	58.8
1987	32.3	36.9	31.9	30.6	31.6	44.5	17.2	58.4
1988	31.8	36.7	30.5	30.1	—	44.7	16.8	58.9
1989	32.7	35.9	29.8	29.8	—	43.4	16.2	59.2
1990	—	35.3	30.2	28.4	—	—	10.9	60.0

NOTE: — indicates data not available.

[a]Data for Norway are for men aged 60 and over.

SOURCE: Organisation for Economic Co-operation and Development (1992:Table 5.2).

Norway[a]	Netherlands	New Zealand	Portugal	Spain	Sweden	United Kingdom	United States
—	—	—	—	—	66.6	—	53.1
—	—	—	—	—	66.0	—	53.2
—	—	—	—	—	65.2	—	53.5
—	—	—	—	—	62.9	—	53.3
—	—	—	—	—	61.7	55.4	52.3
—	39.0	—	—	—	60.0	52.5	51.1
57.7	37.5	—	—	54.6	58.4	51.2	50.0
56.2	36.5	—	—	52.9	56.9	50.2	48.4
53.5	35.0	—	61.8	46.0	55.5	49.1	47.8
53.6	33.5	—	56.8	46.5	54.4	48.2	45.7
53.9	33.4	—	56.0	47.6	52.0	46.4	44.4
53.9	33.0	—	55.8	46.5	50.2	45.2	44.3
53.3	32.6	—	55.2	44.6	49.6	43.4	44.5
52.0	30.5	—	54.6	43.3	49.6	41.8	44.0
49.5	29.3	—	51.6	41.6	49.4	40.3	43.0
50.4	26.4	—	47.4	40.2	48.1	37.3	41.9
48.1	24.9	—	46.5	38.4	47.4	34.4	41.6
47.7	22.3	—	47.2	36.8	46.0	33.8	39.6
45.9	21.3	—	44.9	34.7	45.1	33.5	38.9
42.7	21.5	—	41.8	32.9	44.6	32.4	38.4
42.4	20.0	40.6	39.8	31.7	44.8	30.8	37.9
—	—	38.8	39.7	30.9	44.6	30.6	38.0
—	—	34.7	40.5	29.8	45.5	31.4	37.6
—	—	31.7	41.4	30.1	45.8	32.3	37.4
—	—	—	42.0	29.8	44.3	33.0	37.0


France
Australia
The Netherlands
Japan
Year
Ratio (%)
55-59
60-64
65+

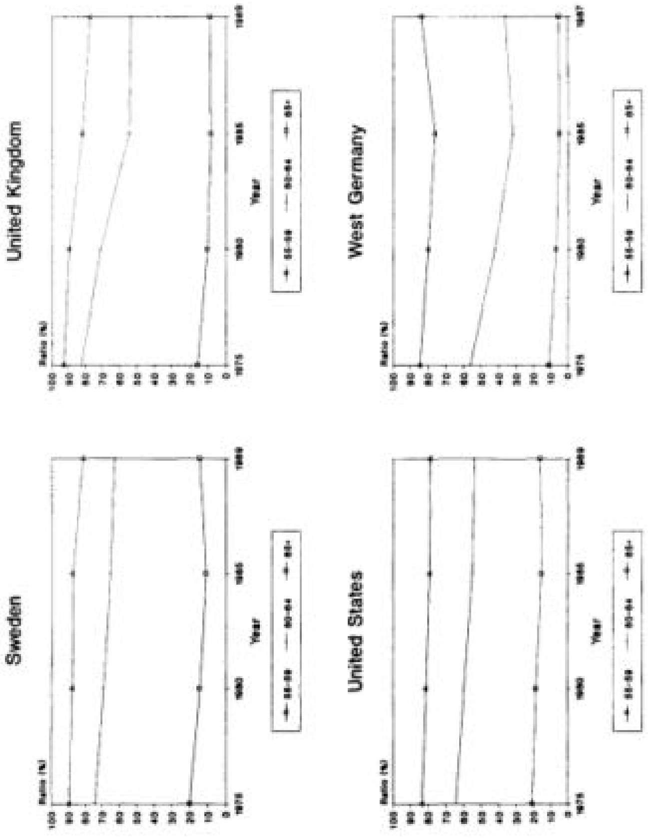


Figure 3-4
Male employment to population ratios in eight OECD countries, 1975-1989.
SOURCE: OECD, *Employment Outlook* (various years).

TABLE 3-2 The Employment-to-Population Ratio for Women Aged 55 and Over (in percent)

Year	Australia	Canada	Finland	France	Germany	Ireland	Italy	Japan
1966	12.0	—	50.0	—	—	25.4	4.1	—
1967	13.2	13.7	48.7	—	18.4	—	6.6	—
1968	13.4	13.9	49.1	28.7	18.4	—	6.2	32.2
1969	13.0	14.5	45.4	28.6	18.2	—	0.0	32.0
1970	13.0	16.6	44.4	27.3	16.5	—	5.1	31.6
1971	13.7	17.3	45.6	25.3	15.0	23.6	5.0	31.1
1972	13.6	16.3	42.9	24.8	14.2	—	4.2	29.8
1973	13.4	16.9	43.4	23.3	13.7	—	4.2	30.7
1974	13.4	16.2	43.0	22.2	12.8	—	4.2	29.4
1975	13.1	16.8	41.9	21.8	11.9	19.6	4.0	29.1
1976	12.7	17.0	39.8	21.7	11.7	—	3.9	29.0
1977	12.8	17.1	39.5	22.1	11.5	17.4	5.3	29.2
1978	11.6	17.3	37.8	21.6	11.4	—	4.8	29.8
1979	10.3	17.7	39.0	21.9	11.3	16.5	4.4	29.6
1980	11.3	17.6	41.1	22.1	11.3	—	4.6	29.5
1981	10.9	17.7	42.2	21.7	11.0	16.0	4.4	29.2
1982	9.3	17.2	43.3	21.0	10.9	—	4.8	29.4
1983	10.0	16.8	44.1	19.7	10.5	15.6	4.2	29.9
1984	9.9	16.7	43.5	19.4	9.9	13.4	4.5	29.3
1985	9.3	16.7	42.7	19.0	9.3	13.1	4.4	29.2
1986	9.7	16.1	39.1	18.6	9.4	12.6	4.6	28.7
1987	10.4	16.4	37.1	18.5	10.1	12.4	4.4	28.8
1988	10.6	16.8	37.2	18.4	—	12.3	4.1	28.9
1989	10.3	16.2	37.8	18.4	—	11.4	4.2	29.4
1990	11.0	16.5	38.2	17.6	—	—	4.2	30.0

NOTE: — indicates data not available.

[a]Data for Norway are for men aged 60 and over.

SOURCE: Organisation for Economic Co-operation and Development (1992:Table 5.3).

Norway[a]	Netherlands	New Zealand	Portugal	Spain	Sweden	United Kingdom	United States
—	—	—	—	—	28.6	—	23.1
—	—	—	—	—	28.1	—	23.3
—	—	—	—	—	28.3	—	23.4
—	—	—	—	—	29.3	—	23.8
—	—	—	—	—	28.7	20.7	23.5
—	6.6	—	—	—	28.1	20.7	23.2
24.4	6.6	—	—	14.2	28.3	20.2	23.0
23.5	6.4	—	—	15.3	28.2	19.6	22.4
20.3	6.2	—	21.3	13.0	28.3	19.4	21.5
22.3	5.9	—	20.6	13.4	29.3	18.9	21.2
25.1	5.9	—	20.2	13.8	30.2	18.9	21.1
26.0	5.7	—	19.2	13.2	29.7	18.8	21.0
26.4	5.7	—	19.8	12.9	30.0	18.0	21.5
25.5	5.9	—	19.7	12.1	30.2	17.2	21.6
22.9	5.9	—	19.0	11.3	30.5	17.0	21.2
24.8	5.2	—	17.7	10.6	31.7	16.8	21.0
24.9	5.3	—	17.4	10.2	32.0	15.8	21.6
24.5	5.5	—	20.2	10.3	32.1	15.0	20.5
26.1	5.1	—	19.2	9.7	31.5	15.4	20.4
24.5	4.8	—	18.4	9.4	31.0	14.5	20.2
24.5	4.4	16.4	17.7	8.9	31.4	14.0	20.4
24.9	—	15.5	17.3	8.9	33.2	14.1	20.4
—	—	15.9	17.9	9.1	34.0	14.2	20.8
—	—	14.5	17.8	8.9	34.2	15.6	21.3
—	—	14.3	18.3	8.6	34.5	15.7	21.4

Part-Time Work

The United States

Not only do fewer older Americans work than previously, but those who do are more likely to work part-time. In the United States, the importance of part-time work rises dramatically with age. Although only 7 percent of employed nonagricultural men aged 25-60 work part-time (fewer than 35 hours per week), 16 percent of those aged 60-64 and nearly half of the men aged 65 and over do (Bureau of Labor Statistics, 1992:Table 33). For women, part-time work is more prevalent at all ages, and shows a similar age differential. Whereas only about 20 percent of the employed women aged 25-54 work part-time, a quarter of those age 55-59, more than a third of those 60-64, and 60 percent of the women 65 and over do (Bureau of Labor Statistics, 1992:Table 33). The vast majority of the older Americans working part-time say they are doing so voluntarily (Bureau of Labor Statistics, 1992:Table 33).

Among older Americans, the proportion working part-time has been growing over time: for men aged 65 and over, from 38 percent in 1970 to 49 percent today; for women, from 50 to 60 percent.[2] In this sense, the early retirement trend may still be under way, but through hours rather than labor force participation.[3]

Other OECD Nations

Part-time employment also appears to be on the rise in other developed nations. The OECD (1983:44; 1991:46) has estimated the extent of part-time employment in member nations in 1973, 1979, 1981, 1983 and 1990. In every case, the proportion was higher in 1990 than in 1973. In most cases, the rise was steady over this time period.

There is great variation in the extent of part-time work in OECD countries. Among all employed men, the proportion part-time ranges from 2 percent or less in Austria, Belgium, Germany, Luxembourg, and Spain to nearly 16 percent in the Netherlands (OECD, 1991:46). Among employed

[2] For all workers, the proportion working part-time has increased modestly in the United States, from 13 percent in 1970 to 15 percent in 1991 (Bureau of Labor Statistics, 1971:Table A-23; 1992:Table 33).

[3] Ruhm (1995) has compared the employment patterns of older men over the past two decades, using the 1969 Retirement History Survey (RHS) and a 1989 Harris poll sponsored by the Commonwealth Fund (see footnote 13). His data confirm that the importance of part-time work rises with age and suggest that the percentage of older employed men (in this case, aged 58-63) working part-time is about 5 points higher than it was 20 years ago.

women, the proportions are always much higher, ranging from about 10 percent in Finland, Greece, Italy, and Portugal to nearly 50 percent in Norway and more than 60 percent in the Netherlands.[4]

Most of the part-time work in these countries appears to be voluntary. The OECD (1990:182) estimates that about two of three male and four of five female part-timers want to work less than full-time. If the United States is any guide, the percentage voluntary would be even higher for the older part-time workers.

Figure 3-5 shows the percentage of the elderly population that worked part-time in eight OECD countries in 1989 or 1990. This ratio combines two factors: the percentage of people who work and the percentage of those working who work part-time. Several interesting conclusions emerge. Among older men, part-time work is inconsequential in Germany and France. In both countries, the vast majority of men are out of the labor force altogether by age 60 and, especially in Germany, very few of those who remain work part-time. Only 3 percent of older Frenchmen (55-64) and 1-2 percent of older Germans are part-time employees. In contrast, part-time work among the elderly seems to be very common in the Netherlands (at ages 55-59) and in Japan and Sweden (after age 60), where 13 and 19 percent of all men aged 60-64 work part-time. The United States is in the middle, because neither our retirement experience nor our part-time employment experience among the elderly is extreme.

For women, the relative U.S. experience depends on the age group under discussion. For those aged 55-64, we are at the low end of the spectrum, not because our labor force participation rates are particularly low, but because relatively few of those employed work part-time. By age 60-64, however, the United States, with 12 percent of the population working part-time, is much more typical. We have moved to the middle of the spectrum because of the much more abrupt retirement patterns among women in other countries. In Germany, France, and the Netherlands, less than 7 percent of the women aged 60-64 are employed part-time. In contrast, 16 percent of British and Japanese women are, and nearly one-third of those in Sweden.

What emerges is that part-time employment is an important part of the labor force withdrawal process in many developed nations. The U.S. experience is in the middle of the spectrum; some countries have a lot less elderly part-time employment and others a lot more. Since more older

[4] Comparisons among countries are difficult because of different definitions of part-time work. Some countries utilize subjective self-descriptions by survey respondents. Others use an objective criterion, such as 30 or 35 hours per week, sometimes based on usual working hours and sometimes on actual hours during a particular reference week. For more detail, see OECD (1989:Annex 1.B.); Thurman and Trah (1990); or Maier (1991).

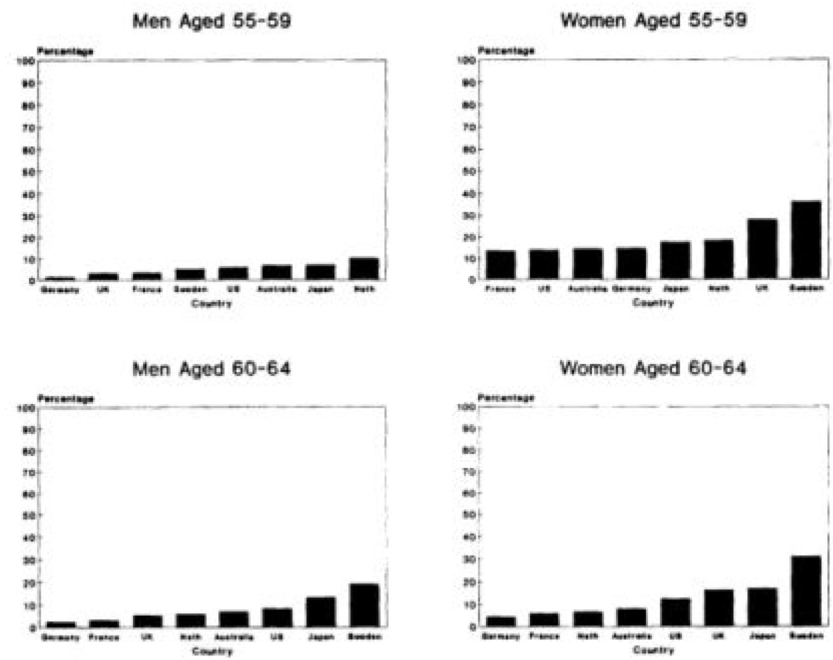


Figure 3-5
Percentage of the population working part-time in eight OECD countries, by age and sex, 1989-1990.
SOURCE: OECD, *Employment Outlook* (various years).

Americans say they want to work part-time than actually do, we may have much to learn from other nations who have been more successful in permitting workers to withdraw gradually from the labor force.[5]

DETERMINANTS OF THE RETIREMENT DECISION

The Early Survey Literature on Retirement

The early literature described retirement transitions that were largely thought to be involuntary.[6] It emphasized the importance of poor health, layoffs, and mandatory retirement policies in the withdrawal process, and was based largely on surveys and analyses done by the U.S. Social Security Administration (SSA).[7]

For example, Wentworth (1945) analyzed a survey of nearly 2,400 male Social Security beneficiaries who were asked why they quit working. Much more than half said they had been laid off, and another third claimed to have retired for reasons of health. Less than 5 percent of the respondents seemed to have retired voluntarily while in good health. A few years later, Stecker (1951) summarized the Wentworth study and three other surveys from the 1940s. She found that the overwhelming majority of Social Security beneficiaries left their last covered employment because they had lost their jobs or had quit for health reasons. Only about 5 percent left because they "wanted to retire." Stecker (1951:15) concluded that "most old people work as long as they can and retire only because they are forced to do so."

In 1951, SSA surveyed more than 15,000 retired beneficiaries aged 65 and over. Nearly 85 percent had either lost their last job or quit because they were unable to work. Stecker (1955:12) concluded that "voluntary quitting to enjoy a life of leisure is rare among old age beneficiaries. Relatively few who are able to work choose retirement."

In 1963, SSA surveyed both beneficiaries and nonbeneficiaries as young

[5] Considerable survey evidence suggests that more Americans would like to work part-time than actually do. For example, in a 1989 Harris survey of older Americans (women aged 50-59 and men aged 55-64; see footnote 13), 6 percent of the wage and salary men and 19 percent of the wage and salary women were actually working part-time. But three times as many of these men (21%) and twice as many of these women (43%) said that they preferred to be working part-time. See Quinn (1992) and Quinn and Burkhauser (1994) for more detail. McNaught et al. (1991) studied those already out of the labor force in the same 1989 Harris survey. They found that a substantial minority (14-24%, by various measures) was willing and able to work, and that the vast majority was willing to work part-time.

[6] The discussion of the determinants of the retirement decision draws on the extensive literature review in Chapters 2 and 3 of Quinn et al. (1990). For more on the voluntary versus involuntary nature of retirement over the years, see Quinn (1991).

[7] An excellent review of this early literature can be found in Campbell and Campbell (1976).

as age 62, and a trend toward more voluntary retirements was first noticed. About 28 percent of the wage and salary workers had retired for voluntary reasons, about twice the percentage in the 1951 survey. Palmore (1964:3) stated that "although most men retire involuntarily—because of poor health ... or because they have reached a compulsory retirement age—voluntary retirements are increasing." Epstein and Murray (1967:105) agreed that "[t]here seem to be more and more aged men who are well enough to work and who might get some kind of job if they were interested, but who prefer the leisure of retirement."

In 1971, Reno reported on a new survey of recent Social Security recipients, in which those not working were asked why they left their last jobs. Nearly half said health, another quarter gave job-related reasons, and 17 percent said they wanted to retire. But in another part of the survey, nearly a third said that they left their last job because they wanted to start getting Social Security or a pension, suggesting that financial considerations might be important.

Reno also found that the proportion who wanted to retire increased directly with the size of their retirement benefits. She concluded that "... financial considerations often underlie the willingness with which men retire early" and that "the level of retirement benefit income had an important influence on the men's willingness to accept or initiate early retirement" (Reno, 1971:12-13).

More recently, Packard and Reno (1989) reported on a 1982 survey of new Social Security beneficiaries, in which answers suggested that more retirements were voluntary than involuntary. The proportion voluntary rose with the age of retirement (up to age 65) and was much higher for those with pensions. Overall, about one-third said that they wanted to retire, more than the quarter who named health as the primary reason.

The Early Econometric Literature

Economists are interested in the role of incentives. Survey responses and circumstantial evidence suggested that financial incentives might be important in the retirement decision. Retirement and early retirement rates rose dramatically in the United States as Social Security and employer pension systems expanded. Noticeable changes in labor force behavior occurred at ages important in pension and Social Security rules—60, 62, and 65. Workers' wage earnings were found to cluster around the levels at which the Social Security earnings test went into effect.[8]

[8] See Burtless and Moffitt (1984) and Kahn (1988) for dramatic illustrations of the clustering of earnings below the Social Security exempt amount.

The early econometric literature hypothesized that many retirements are labor supply choices—individuals doing what they judge best given the options they face. The early studies were, in retrospect, unsophisticated in a number of ways. They were one-period labor-leisure models that ignored the essential multiperiod nature of pension and Social Security promises, and they utilized very simple measures of the financial incentives facing those contemplating retirement. Nonetheless, they yielded reasonable results that began to change the accepted wisdom on the process of retirement, and they encouraged a flood of more sophisticated research.

Quinn (1977) published one of the earliest econometric studies using the Social Security Administration's Retirement History Study (RHS). Using only the first cross-sectional wave of about 11,000 men and (nonmarried) women aged 58-63 in 1969, he found that current labor force status (in or out) depended on health, the presence of dependents, asset income, local labor market conditions, certain job characteristics, and most important for our purposes, eligibility for Social Security and/or employer pension benefits. Those currently eligible for benefits were much more likely to be out of the labor force. But the study ignored the size of the benefits and how these benefits might change were the individual to work for another year.

Boskin (1977) studied a small sample of older men from the Panel Study of Income Dynamics and estimated the maximum Social Security benefit for which each household would be eligible. The results suggested very strong Social Security effects—the larger the potential benefit, the more likely the person was to retire. Unfortunately, he had no information on pension eligibility or benefits, and also ignored the fact that the benefits would rise if retirement were delayed.

Burkhauser (1979, 1980) was the first to emphasize the multiperiod nature of Social Security and pension rights, and argued that the theoretically appropriate and empirically important concept was not a dichotomous eligibility variable (as in Quinn, 1977) or the size of the annual benefit (as in Boskin, 1977), but rather the present discounted value (PDV) of the entire benefit stream. He showed that this PDV (or changes in it, called pension accrual—see below) was an important determinant in the decision of autoworkers contemplating an early pension and of other workers considering early Social Security benefits at age 62.

The key insight here was to view retirement income rights as an asset, a stock of wealth, that could rise or fall depending on when the benefit was claimed. When the receipt of a retirement benefit is delayed (e.g., by working another year), two things happen. The bad news is that current pension income is forgone, say, $10,000. The good news is that future annual benefits will be higher. For Social Security, they will increase because average monthly earnings (on which benefits are based) will rise and because Social Security adds a delayed retirement credit to all future checks. For defined benefit pension plans, benefits are usually based on some combination of last or highest earnings and years of service, both of which are likely to rise with continued work.

The choice, then, is not simply between a pension check and no pension check in that hypothetical year; rather, it is between two streams of income, one starting immediately, with smaller annual amounts, and another commencing later, but with higher benefits each year. Which is more valuable—more small checks or fewer large ones?

The answer depends on whether the future annual increments are sufficient to compensate for the pension income initially forgone. If the increments just compensate, the pension is called actuarially fair. If the future additions are more than sufficient, then one gains twice by working that additional year, both through the paycheck and through the increase in pension or Social Security wealth. But if the future increments are worth less than the benefits forgone, then pension wealth declines with additional work. In this case, true compensation is less than the paycheck by the amount of the wealth loss. This simple concept and the existence of several outstanding data sets spawned the voluminous literature discussed below.

The Modern Econometric Literature

Economists have adopted two strategies to study retirement incentives. Most have used one of the large microeconomic data sets on older workers (such as the RHS or the Labor Department's National Longitudinal Survey (NLS)) to ask who retired, who did not, and under what circumstances. The advantage of this approach is extensive demographic and economic information on a large sample of potential retirees and access to their Social Security earnings records. The disadvantage is scanty data on their employer pensions. The second approach involves analysis of actual pension plans, with all their detail; the price paid is limited information on the people in the plans. Fortunately, these two strategies yield similar conclusions.

Recent research has established that Social Security and many defined benefit pension plans contain strong retirement incentives (work disincentives) at specific ages. They do so with benefit calculation rules under which the future annual pension increments following an additional year of work are inadequate to compensate for the benefits initially forgone; in other words, the asset value of one's Social Security or pension declines with additional years on the job. By working, one earns a paycheck and simultaneously loses retirement income wealth. This is a decrease in net compensation—a pay cut—not via the paycheck, which would be illegal, but through the benefit calculation rules of Social Security and many employees' pension plans.

Accrual Patterns

Burkhauser and Quinn (1983a) and Quinn and Burkhauser (1983) used the RHS to estimate the size of the Social Security and employer pension incentives in the mid-1970s. We found that Social Security wealth rose slightly with continued work for the median full-time worker at age 63 and 64—future increments slightly outweighed the initial benefits forgone. But at age 65, because of the drop in the delayed retirement credit from about 7 to only 1 percent per year of delay (it is now 4%), Social Security wealth decreased sharply for those who continued to work to age 66. The median wealth loss was about a third of annual pay—a significant pay cut indeed. The pension story was similar, although the estimates were less reliable because the RHS pension data were much more limited.[9]

Fields and Mitchell (1984c) examined the details of 14 specific pension plans and estimated the incentives facing workers at each age between 60 and 68. They found that the asset value of pension rights tended to rise and then fall, peaking between the ages of 60 and 65. With samples of men from one of their pension plans and from the RHS, they calculated total lifetime income (from age 60 on) for hypothetical retirement ages between 60 and 68—the sum of the present values of earnings, Social Security, and pension benefits. This total rises with each year of additional work because earnings exceed retirement benefits. But the *increase* in the total (the true compensation for the additional year of work) falls monotonically and at age 68 is less than 40 percent of what it was at age 60. This is the declining compensation profile facing older Americans.

Finally, Kotlikoff and Wise (1989) studied nearly 1,200 American plans and found that pension accruals for the typical plan were negative for those who worked past the normal retirement age in the plan. In many pensions, accruals were negative after the earliest age of pension eligibility. They found that it was not unusual for the annual loss in pension wealth to equal 30 percent of annual wage earnings.

Because of this research, it is now generally agreed that retirement income rights are best viewed as assets whose values depend on when they are first claimed. Changes in these asset values with continued work (pension accruals) are part of compensation, and wealth losses are equivalent to pay cuts. At some age—certainly by 65 but often much earlier—accruals become negative, and therefore net pay begins to decline, providing strong incentives to retire.

[9] The RHS includes actual Social Security records for all respondents, which allows researchers to calculate potential Social Security benefits precisely. The pension data include details on eligibility and benefits, but not on how benefits would change with continued work. We had to use industry-wide averages for these details.

The Impact of Retirement Incentives on Behavior

Considerable research indicates that many workers respond to these incentives by leaving career jobs, and often the labor force as well, when these pay cuts occur. Burkhauser (1979) showed that autoworkers were more likely to leave the firm as the pension wealth loss associated with continued work increased. Rhine (1984) found that employees in companies with attractive early-retirement benefits were more likely to retire early than those in companies without such inducements. With a large sample of older workers from the RHS, Burkhauser and Quinn (1983b) found the same for both Social Security and pension wealth changes. We concluded that at least half of what looked like a mandatory retirement effect at age 65 was really due to the financial incentives that occurred at the same time.

Burtless and Moffitt (1984, 1985, 1986) confirmed that the Social Security system influences labor supply behavior. They found a dramatic clustering of retirement around the ages of 62 and 65, and showed that retirees who continued to work reported earnings clustered around the amount that Social Security permits without loss of benefits. Sickles and Taubman (1986), also using the RHS, combined earnings and the change in Social Security wealth into one variable and found that it was the most significant of the income variables in explaining retirement behavior.

As mentioned above, Fields and Mitchell (1984b) used a very different methodology and a different data set, choosing to delve more deeply into the actual details of a small number of pension plans. When the incentives and individual behavior were compared, they concluded that those with the most to gain by postponing retirement tended to retire later. Similarly, Kotlikoff and Wise (1989) studied the employees of one particular firm for which they knew exact pension details, and showed that departure rates at specific ages coincided precisely with the discontinuities in worker compensation that resulted from Social Security and pension plan accruals.

Because the two main microeconomic data sources for much of the retirement research focused on men, there is much less literature on the retirement decisions of women.[10] In very recent work, Reimers and Honig (1993a,b) and Honig and Reimers (1992) suggest that (white nonmarried) women may be more sensitive to these financial incentives than men. According to their results, women have longer time horizons and are more likely to view Social Security in a long-run, present discounted value fashion rather than just looking at the level of current benefits. On the other

[10] The Labor Department's National Survey of Older Men sampled only men, and the Social Security Administration's Retirement History Study surveyed men and nonmarried women. There were limited data on the work histories of the wives of the married men in the RHS, but nowhere near as much information as was available for the primary respondents.

hand, in one of few other studies comparing behavior by gender, Lumsdaine et al. (1994) find no statistically significant differences in the retirement patterns of older men and women employed by a large Fortune 500 firm; in particular, their response to a retirement bonus available for two months in 1983. This is an area in which research is long overdue.[11]

Gustman and Steinmeier (1994) have analyzed the impact of another incentive—health benefits after retirement—on the timing of the retirement decision. They find that workers tend to delay retirement at least until the date at which they become eligible for these benefits, and then are slightly more likely to retire once eligible. The net effect is a very small decline in average retirement age.

Exit Patterns from Career Jobs

Researchers have recently begun to analyze the exit routes that older Americans take between full-time work on a career job and complete labor force withdrawal. Although many still make this transition in one step, many utilize one or more bridge jobs between the two. Despite the fact that most of the economic literature treats retirement status as dichotomous, Americans actually leave their career jobs in many diverse ways.

Quinn et al. (1990) defined a career job as full-time employment held for at least 10 years. Following the RHS sample from 1969, when the respondents were 58 to 63 years old, until 1979, when the biennial surveys ended, we found that a substantial minority did not leave the labor force when they left full-time status on a career job. Among wage and salary workers, one-quarter did something else—most found new employment and a few dropped to part-time on the career job. Among the self-employed, with more control over the amount and kind of work they do, only half left the labor force. One-quarter remained part-time on the same job, and the other quarter found new work.

Most of these transitional jobs were more than short-term employment. Of those who switched employers, nearly three-quarters were still on the new job a year later, and nearly 60 percent remained after two years. A comparison of the career and bridge jobs revealed that most of the transitions involved movement to different occupations and industries. More people moved down the socioeconomic ladder—from skilled to unskilled and from white collar to blue collar—than moved up. There were many

[11] There is even less evidence on racial differences in the response to financial incentives, since the sample sizes of racial minorities in the large microeconomic retirement data sets have been too small. The new Health and Retirement Study, discussed later, samples older men and women, and oversamples blacks and Hispanics. This will permit analyses of these important and growing subgroups.

more hourly wage cuts than increases.[12] There was weak evidence that those at the ends of the economic spectrum were more likely to stay in the labor force after leaving career employment—the poor probably because they had to and the rich because they wanted to.

Ruhm (1995) has analyzed a sample of men aged 58-63 from a much more current data set—the 1989 Commonwealth/Harris survey—and compared his findings with those on men of the same age from the 1969 RHS sample.[13] Not surprisingly, he finds higher retirement rates today than 20 years ago. He also finds much larger employment drops at the ages of 60 and 62 now than there were then. These are important ages for pension and Social Security eligibility. In 1969, the cross-sectional employment rate dropped about 2 and 5 percentage points at ages 60 and 62, respectively; in 1989, the respective declines were 13 and 18 points.

Ruhm also found substantial bridge employment. Between 30 and 40 percent (depending on the age) of those employed in 1989 were working on a postcareer bridge job, and for all ages but one, these percentages were higher in 1989 than they were for people the same age in 1969.

This research shows that dichotomous definitions of retirement, no matter what the definition used (e.g., labor force participation, a large decline in hours worked, receipt of pension or Social Security benefits, or self-defined status), miss much of the story. Retirement routes in America are many and varied. The stereotypical transition—directly from full-time work to full-time leisure—is only part of the story. A substantial minority of Americans do something other than leave the labor force when they leave their career jobs. For many, the transition involves part-time employment, usually on a new job, in a new line of work, and at lower pay. There are offsetting advantages, such as flexibility of hours, different working conditions, and for many, the ability to claim a career job pension when its asset value is at its peak.[14]

Uncertainty, Option Value, and Dynamic Programming Models

Most retirement models implicitly assume a world of certainty in which people base decisions on their current situations and their best estimates of

[12] Wage rate declines were particularly dominant when the new job was part-time, with the exception of the few who were able to shift from full-time to part-time on their career jobs.

[13] In 1989, under the auspices of the Commonwealth Fund, Louis Harris and Associates conducted telephone interviews with 3,500 older Americans—women aged 50-59 and men aged 55-64. About 2,000 were still working, and the other 1,500 had already left the labor force.

[14] Ruhm (1990) reports that nearly 60 percent of those in the Commonwealth/Harris survey who were in bridge jobs said that it was the most enjoyable job they had ever had.

the future. In fact, however, there are probability distributions around these best estimates, and these distributions change over time. Health can vary, and layoffs can occur. Labor market conditions can improve or deteriorate. Retirement benefits can differ from expectations, either because individuals did not understand the details initially or because the rules changed after their initial expectations were formed.[15]

Anderson et al. (1986) compared the planned and actual retirement dates of nearly 1,600 male workers in the RHS and found that the majority (about 60%) left work within a year of their predicted date. More retired earlier than they had planned rather than later, and the proportion as expected increased with the person's age at the time of the prediction. More importantly, changes in plans were correlated with changes in the environment, in particular, with the unanticipated increases in real Social Security benefits in the late 1960s and early 1970s, with changes in individual health status, and with changes in local labor market conditions. Increases in Social Security wealth and health deterioration increased the probability of retiring earlier than planned and decreased the likelihood of retiring later; an increase in local unemployment rates did just the opposite. This research shows that plans do change and that models based on assumptions of certainty will miss part of the story.

Much of the most current and most sophisticated research on retirement focuses specifically on issues of uncertainty. Rust (1989), Stock and Wise (1990), Berkovec and Stern (1991), and Lumsdaine et al. (1992) have developed models in which individuals recalculate their optimal behavior each time period, using new information about the present and their current best predictions about the future. The computational requirements of some of these models are extreme, so they are usually simplified in other ways. For example, in Rust's stochastic dynamic programming model, which allows individuals to optimize over age of retirement and future consumption simultaneously, he has no pension plan incentives and assumes that unobserved individual factors, such as health and work-leisure preferences, are uncorrelated over time—an unlikely prospect.

What makes these models interesting is that they do not assume that workers know their future wage rates and retirement benefits with certainty, and they allow comparisons of current retirement with retirement at all future dates. In the Stock and Wise (1990) model, for example, a worker

[15] Mitchell (1988) compared workers' descriptions of key features of their pension plans with the actual features provided by their employers, and found missing and incorrect information to be widespread. Although automatic cost-of-living adjustments are not common in private sector pensions, Allen et al. (1986b) have argued that postretirement inflation adjustments in fact are fairly common, even when employers have no contractual obligation to do so. But it may be difficult for workers to predict their firms' behavior years ahead. Currently, for example, many firms are reconsidering their commitment to retired health benefits.

decides whether to retire from the firm today by forecasting future wages and retirement benefits, and then estimating the present discounted value of total compensation (earnings plus pension and Social Security accruals) associated with each potential departure date in the future. If any future date looks better, given his labor-leisure preferences, he continues to work. Once he leaves, he cannot return to the firm. By continuing to work, the individual retains the option of leaving later, at a more advantageous age. This is the "option value" of work.

After another year on the job, the worker has more information about the future, based on his actual earnings during that year and any other relevant knowledge he has acquired. He must then make another retirement decision, again comparing immediate retirement with retirement in all subsequent years. The forecasts of future conditions will be different from what they were a year ago, because of the new information. Critical to these models are assumptions about how expectations are formed and how sensitive they are to new information, both of which are difficult to model.

The Stock and Wise results are consistent with the previous literature. Pension incentives are very important. Using personnel data from a large Fortune 500 firm, they find that discontinuities in actual retirement rates correspond closely with the incentives of the pension plan, and predict that changes in the pension plan (such as a delay in the early retirement age or a switch from defined benefit to defined contribution) would have dramatic impacts on retirement patterns—impacts much larger than those predicted in other papers for Social Security reform.

Berkovec and Stern (1991) propose a much more complicated dynamic programming model, in which workers choose among four states—remaining on the current job, switching to a new full-time or a new part-time job, or leaving the labor force. Once retired, the individual can choose to stay retired, or can accept a new full-time or a new part-time job. These choices are made each period, based on current and expected wages, pensions, and preferences for leisure. Since the model does not include Social Security, their predictions miss important discontinuities in retirement behavior at ages 62 and 65. Nonetheless, they report that their dynamic model outperforms an analogous static model and urge that model dynamics be included explicitly in the estimation procedure.

Lumsdaine et al. (1992) focus directly on the issue of model complexity and predictive validity. Closer approximation to individual behavior often requires an increase in the complexity of the model. At some point, however, the complexity may exceed the actual decision-making processes at work, and predictive power may decline. In addition, computational burdens associated with complexity may require other simplifications in the model that reduce its usefulness.

Lumsdaine et al. compare the out-of-sample predictive power of three models of increasing complexity—a traditional probit model, an option value model such as that of Stock and Wise (1990), and a dynamic programming model like that of Berkovec and Stern (1991). They report that the latter two predict subsequent retirement behavior of a sample of workers from a single firm about equally, but that both significantly outperform the simpler, less forward looking probit model. This suggests that some increases in model complexity are worthwhile, but that others may not be.

Demand-Side Analysis

Most of the recent retirement literature has taken a supply-side perspective—workers are assumed to choose which of several options to take, based on their preferences and the financial incentives they face. But there has also been a revival of demand-side interest, reminiscent of the early literature on involuntary retirement, asking whether older workers face restricted job opportunities as they age.

Although the official unemployment rates of older workers are lower than those of the labor force as a whole, older Americans are more likely than others to be discouraged workers—out of work but no longer looking and therefore not counted as unemployed.[16] Although workers aged 55 and over (in the mid-1980s) were about as likely as younger workers to be laid off, those who were laid off were much more likely to end up out of the labor force—one-third of those aged 55-64, three-quarters of those 65 and over, but less than 10 percent of those 20-54 (Herz and Rones, 1989). Shapiro and Sandell (1987) studied older workers who were laid off or fired between 1966 and 1978, and found that older job losers were more likely than others to experience long spells of unemployment and suffered greater earnings reductions when they did find work. Layoffs were also highly correlated with retirement. Almost 30 percent of male job losers aged 60 retired, compared to only 10 percent of those still employed.

Hutchens (1986, 1988, 1991) hypothesizes that firms with high fixed costs of hiring or training prefer a younger worker to an otherwise identical older worker, since the younger worker has more years of labor to offer the firm and therefore more years to amortize the fixed costs. In a job search framework, the distribution of job offers to a worker will depend on that worker's expected job duration, and job offers will be less frequent or the jobs less attractive as the age of the worker increases.

Hutchens (1991) tests this theory with a sample of recently displaced

[16] Herz and Rones (1989) showed that the inclusion of discouraged workers adds more than a third to the unemployment rate of men aged 55 and over and adds more than 70 percent for analogous women, but has only a very small effect on the unemployment rate overall.

men aged 30-59, and finds some weak support for his hypotheses—the proportion of those laid off who are unemployed or out of the labor force increases with age, and the older workers (50 and older) who did find work were paid less than those aged 40-49. He wonders whether stronger results were not masked by selectivity bias—the possibility that the two-thirds of the older workers who were reemployed were the most talented of the group. Those unemployed and out of the labor force would have been paid even less than those actually employed had they found work.

Straka (1992) has provided an outstanding up-to-date survey of the demand-side literature, and concludes that the options facing older workers may be considerably more limited than the supply-side literature has assumed. He does not attribute much of this to age discrimination per se, but rather to sources of labor market adversity, often privately efficient, that happen to increase with age. These include reduced incentives for human capital accumulation, skill obsolescence, physical limitations, fixed costs of employment (as emphasized by Hutchens), and long-term, mutually beneficial implicit contracts between employers and employees that require either a mandatory retirement date or a significant cut in compensation late in the life-cycle.[17] Straka concludes that without the elimination of some of these demand-side obstacles, attempts to increase the working lives of older Americans through antidiscrimination legislation or supply-side measures (such as the elimination of Social Security work disincentives—see below) may be ineffective.

Summary of the Retirement Literature

The retirement decision is known to be a complicated one, influenced by an individual's mental and physical health, attitudes toward work and leisure, job opportunities, social networks, living arrangements, financial circumstances, and expectations about the future. Recent developments in

[17] Lazear (1979) has argued that firms might lower turnover costs by paying workers less than their contribution to the firm during the early years of employment and then more than their contribution at the end. In essence, some of the compensation is delayed in order to encourage the worker to stay with the firm. If such a system reduces turnover costs and the gains are distributed to both the employer and the employees, both parties can benefit. But at the point when lifetime compensation and lifetime contribution (marginal product) are equal, the employment contract must be terminated, or the worker's compensation must be decreased to the level of the marginal product. Although this agreement looks discriminatory at the end, it has in fact benefitted the workers over the life-cycle. This theory offers an explanation for both mandatory retirement, which has since been outlawed, and pension plans that penalize workers who stay on the job "too long."

economics have focused on the extent and impact of the financial incentives embedded in Social Security and in many defined benefit employer pension plans. These incentives can alter compensation patterns over time, augmenting pay with positive pension accruals early in the life-cycle (and thereby discouraging job mobility), and reducing pay with declining and often negative accruals later in life. These pay cuts encourage departure from the career job and the labor market as well.

Research has shown that these pay cuts can be large and that they do influence behavior. Other things equal, worker who would suffer large losses in Social Security wealth (at age 65) or private pension wealth (at different ages in different plans) are likely to leave the firm and the labor force. People behave as though they understand and respond to these incentives.

Research also suggests that the pension effects, for those covered by defined benefit plans, are much more important than the Social Security incentives. Numerous simulations of various Social Security reforms all suggest that their aggregate effects would be small—on the order of months, not years.[18] On the other hand, pension incentives and their behavioral effects are dramatic, as the review by Lumsdaine and Wise (1994) makes clear. For this reason, when discussing future retirement trends below, we put great emphasis on the future direction of employer pension incentives. As we will see, there are some indications that work disincentives may become less important in the future.

Disability Benefits as a Means of Retirement

The decline in male labor force participation begins well below the earliest age of eligibility for public retirement benefits in the United States and in other industrialized countries. These declines and a simultaneous increase in the disability transfer rolls have generated a growing literature on disability policy that parallels the retirement research discussed above.

Table 3-3 shows the ratio of persons on disability transfer programs per 1,000 active labor force participants in the United States, Germany, Sweden, and the Netherlands between 1970 and 1989. As recently as 1970, this ratio was approximately 50 per 1,000 in the three European countries and about one-half that in the United States. During the 1970s, the rate more than doubled in Holland, and increased by more than 50 percent in the United States and more modestly in the two other countries. During the 1980s, the rates leveled off in three countries and declined in Germany.

Since people are more likely to suffer ill health as they age, the ratio of

[18] See Fields and Mitchell (1984a), Burtless and Moffitt (1984), Gustman and Steinmeier (1985, 1991), and Gohmann and Clark (1989), described in detail in Quinn et al. (1990:Chapter 3).

disability transfer recipients to workers increases with age. Table 3-3 documents this pattern. But it is difficult to imagine that narrow health-related changes are responsible for such dramatic differences in disability transfer rates across countries or shifts in these ratios over time.

TABLE 3-3 Disability Transfer Recipients per 1,000 Active Labor Force Participants, 1970-1989

Age and Country	1970	1975	1980	Percentage Change 1970s	1985	1989[a]	Percentage Change 1980s
15-64							
Netherlands	49	77	126	157	130	139	10
United States	27	42	41	52	51	43	5
Sweden	49	67	68	39	74	78	15
Germany	51	54	59	16	72	55	–7
15-44							
Netherlands	14	28	49	250	50	53	8
United States	11	17	16	45	20	23	44
Sweden	18	20	19	6	20	21	11
Germany	7	6	7	0	8	5	–29
45-59							
Netherlands	102	164	269	164	279	317	18
United States	33	68	83	152	71	72	–13
Sweden	66	95	99	50	108	116	17
Germany	75	64	84	12	103	75	–11
60-64							
Netherlands	274	410	989	261	1,249	1,932	95
United States	154	265	285	85	254	250	–12
Sweden	229	382	382	67	512	577	51
Germany	419	688	1,348	222	1,291	1,109	–18

[a]The numbers for the Netherlands refer to 1990.

SOURCE: Aarts et al. (1992).

An alternative explanation is provided by Haveman et al. (1984) and by Aarts et al. (1992), who find evidence for a policy-generated disability "epidemic"—changes in disability policy that induced a rapid increase in the "disabled" population during the 1970s and stabilization in the 1980s. They argue that much of this disability population would have been unemployed, retired, or in some instances, still working under different policies.

Providing empirical evidence for this conjecture is difficult. Bound and Waidmann (1992) attempt to do so for the United States. They use trends in self-reported disability to infer the impact of disability transfer programs on the labor force attachment of older working-age men. They argue that about one-half of the 5 percentage point drop in the labor force participa tion rate of men aged 45-54 and about one-third of the 20 percent drop for men aged 55-64 between 1949 and 1987 is due to movement onto the disability rolls.

Using a series of cross sections from the National Health Interview Surveys (NHIS), Bound and Waidmann find an increasing prevalence of self-reported disability during the 1970s and a concurrent rise in the proportion of men reporting specific chronic conditions. But they argue that such a rise in morbidity is inconsistent with medical advances and personal health habits that should have improved the health of this population.

Bound and Waidmann offer four alternative explanations: that earlier diagnosis of preexisting conditions led to higher self-reported prevalence in the NHIS data; that improved survival increased morbidity; that deinstitutionalization increased the number of NHIS respondents who were mentally ill; and finally, that economic and disability policy variables led people to exaggerate their health problems. They then argue that this last effect is by far the largest and best explanation.

Inferences of this sort suggest that disability policies that attempt to offset income losses associated with poor health can have an important independent effect on labor force participation. Econometric modeling of this relationship in the United States has proven to be difficult and controversial.

Determinants of the Disability Retirement Decision

A number of early studies used time-series data to explore the link between the labor force participation of older men and increases in the disability rolls. Hambor (1975) found that application rates to the Social Security disability insurance program increased when unemployment rates increased. Leonard (1979), using time-series regressions, found that labor force participation was sensitive to macroeconomic fluctuations and disability insurance characteristics.

Parsons (1980) published the first study of the labor supply effects of disability insurance based on individual microdata. He estimated labor force participation as a function of the ratio of Social Security disability benefits to wages (the replacement rate) and health, using 1969 cross-sectional data from the National Longitudinal Survey of Older Men (aged 45-59 in 1966). He avoided the problem of a contemporaneous self-reported measure of health by using information from subsequent years of the NLS— whether the person died between 1969 and 1976—as a proxy for prior (1969) health status.[19] Parsons' main finding is a strong elasticity of

[19] Variations of this "objective" approach have been employed by others. Anderson and Burkhauser (1984, 1985), using mortality experience in subsequent years of the RHS, show that such a measure yields quite different results than a self-reported measure of health on the labor force participation behavior of a 1969 cross section of men aged 58-63.

nonparticipation with respect to the replacement rate that, if correct, would explain most of the decline in labor force participation rates of men aged 45-59 in the 1970s.

Leonard (1979), using cross-sectional data from the Social Security Survey of Health and Work Conditions, and Slade (1984), using a single cross section from the RHS, also found significant and relatively strong elasticities with respect to the replacement rate, although Leonard's elasticity is only about one-half the size found by Parsons (1980).

Haveman and Wolfe (1984) estimated labor supply equations for men aged 45-62 using a cross section from the Panel Study of Income Dynamics (PSID) and found much weaker elasticities.[20] They also showed that Parsons' results are sensitive to the specification chosen. In more recent work Haveman et al. (1991) used more sophisticated data, the 1978 Survey of the Disabled, and methodology, a switching regression to account for the potentially endogenous process that separates wage earners from transfer recipients. They employed longitudinal earnings data to measure expected changes in income and estimated latent health status separately, in an attempt to purge it of endogeneity in the participation decision. Having done so, they continue to find a relatively small elasticity of nonparticipation.

All of these studies find that disability transfer programs do affect labor supply decisions. However, with different data sets, different measures of health, and different methodologies, they yield dramatically different elasticities of labor supply to disability benefits. A major reason for this is that none of the studies completely overcomes the problem that one cannot observe the wages of those who are out of the labor force or the disability benefits of those at work. This basic censoring problem plagues this line of research. Much of the difference in results across these studies is due to the manner in which they estimate these missing values.[21]

Work Following Disability Denial

Another branch of this literature analyzes the subsequent work behavior of those who apply for disability benefits but are rejected. In an early study, Treitel (1979) followed the employment outcomes of men who were denied disability insurance benefits in 1967. Almost 40 percent did not work at all during the first four years following rejection. In a follow-up to

[20] Haveman and Wolfe (1984) use a self-reported measure of health rather than a more objective measure. This may partially explain the differences between their results and those of Parsons (1980).

[21] For past reviews of this literature, see Leonard (1986) and Wolfe (1987).

this work, Bound (1989) used data from the 1972 and 1978 Surveys of the Disabled and found that only about one-half of rejected disability applicants returned to work. This suggests that for many applicants, health constraints are so great that a return to work is unlikely even if they are denied benefits. But in a recent exchange, Parsons (1991) and Bound (1991) recognize that applying for disability benefits may have a "scarring" effect that must be considered in evaluating the policy implications of these results.

The fact that many unsuccessful applicants do not return to work does not mean that work decisions are unaffected by disability policy. Substantial time can elapse between the onset of a health condition, its first impact on work performance, and its subsequent influence on job exit and application for disability benefits. Application is a risky gamble in which the outcome can be delayed for some time. Those who take this gamble and lose may have permanent "scars" from the experience, in that they emerge from the process either less able or less willing to work than they were when they first applied. Parsons (1991) argues that the scarring hypothesis is quite plausible because the process was often very lengthy during the 1970s. Applicants for disability benefits had to "invest" in not working in order to maximize their chances in the review process. This time out of the market may have lowered their subsequent chances of reemployment, even if they were ultimately denied benefits. Bound (1989) concluded that for most applicants, both those who are accepted and those who are denied, the decision to apply for benefits is tantamount to a decision to withdraw permanently from the labor market. But the size of disability benefits and the likelihood of receiving them may still affect the point at which health-impaired workers take that gamble.

This research suggests that the decision to leave one's job and apply for disability benefits is not just medically determined. Rather, it can be influenced by the work environment as well as the size and likelihood of benefits. Therefore, much of what we have discussed above about modeling the retirement decision may be relevant to the decision to apply for disability benefits.

This is the strategy that Burkhauser et al. (1992b) use to estimate the time between the onset of a health condition that affects work and the application for disability benefits. They assume that an individual's decision to apply is equivalent to deciding whether or not to work. The impaired worker's problem is to choose the optimal age at which to apply.[22]

[22] This variation of a dynamic optimal retirement age model is similar to the full information dynamic retirement models of Burbridge and Robb (1980) and Fields and Mitchell (1984b), which assume fixed labor hours over time and find the optimal retirement age given an employer pension and Social Security. The hazard model that Burkhauser et al. (1992b) used to estimate their theoretical model is a variant of that used by Hausman and Wise (1981), Diamond and Hausman (1984), and Halpern and Hausman (1986).

Using the 1978 Survey of the Disabled, they find that the replacement rate (as estimated by Bound, 1989) significantly affects the speed at which men apply following the onset of a work-limiting health condition.

Accommodating the Disabled

Dissatisfaction over the poor employment experience of people with disabilities has resulted in major legislation-mandated job accommodation. The Americans with Disabilities Act of 1990 (ADA) became fully operational in July 1992 for firms with 25 or more employees. It requires employers to make reasonable accommodations to workers with disabilities as long as this does not create an undue hardship on the business. As the previous discussion has shown, why the overall work experience of the disabled population is so poor is not known. By definition, such workers have health conditions that impede their ability to work to some extent. The economic research has focused on the supply side of the market; demand issues have been virtually ignored. Yet it is the demand side of the market that advocacy groups believe is most responsible for the poor work experiences of those with disabilities.[23]

There is little doubt that on average, people with disabilities in the United States have lower real household income and lower real wages than others. Table 3-4 shows that in 1987, the median income of U.S. households containing a male with a disability was 72 percent of that of households headed by males without a disability. For women, the analogous ratio was 70 percent. One reason for these differences is that the wage earnings of those with disabilities comprise a smaller share of total income than is true in other households. In Germany, however, men and women with disabilities do much better. Men with disabilities live in households whose median income is 97 percent that of households headed by able-bodied men. The ratio for women is 96 percent. The higher ratios are due partly to the fact that the wage earnings of Germans with disabilities are much closer to those of Germans without disabilities than is true in the United States. One explanation for this is that the German government has actively intervened

[23] An exception in the economics literature is Johnson and Lambrinos (1985), who attempt to measure the part of the wage difference between those with and without disabilities that is caused by discrimination. Their study does not consider the importance of discrimination in employment. In the health literature, Nagi (1974) and Yelin et al. (1980) use cross-sectional data to show that job modifications by employers increase the likelihood that a worker with disabilities will continue to work.

TABLE 3-4 Median After-Tax Household Income and Its Sources for Men and Women With and Without Disabilities in the United States and the Federal Republic of Germany[a]

	United States			Germany		
Income	With Disabilities	Without Disabilities	Relative Shares[b]	With Disabilities	Without Disabilities	Relative Shares[b]
Men						
Median income	$18,635	$25,967	0.72	DM 31,709	DM 32,637	0.97
Own wage earnings	0.43	0.66	0.65	0.52	0.66	0.79
Earnings of other household members	0.30	0.22	1.36	0.27	0.20	1.35
Transfer income	0.18	0.02	9.00	0.11	0.04	2.75
Other income	0.09	0.10	0.90	0.10	0.10	1.00
Total	1.00	1.00		1.00	1.00	
Women						
Median income	$17,311	$24,611	0.70	DM 30,465	DM 31,814	0.96
Own wage earnings	0.23	0.28	0.82	0.26	0.23	1.13
Earnings of other household members	0.51	0.58	0.88	0.44	0.62	0.71
Transfer income	0.16	0.04	4.00	0.19	0.05	3.80
Other income	0.10	0.10	1.00	0.11	0.11	1.00
Total	1.00	1.00		1.00	1.00	

[a]Median income is median net of tax income adjusted for household size by using the equivalence scale implied by U.S. poverty line. The in-cash value of food stamps and owner-occupied housing is included in income in the United States. In Germany, the value of owner-occupied housing is included. Income is in 1991 dollars or 1991 deutsche marks. Shares are the mean category income divided by mean pretax posttransfer income. U.S. estimates are based on PSID, sample year 1988. German estimates are based on the GSOEP, sample year 1988.

[b]Relative share equals the median share of people with disabilites divided by the median share of people without disabilities.

SOURCE: Compilation from Burkhauser and Daly (1994).

in the labor market with specific employment quotas to protect people with disabilities.[24]

But even if quotas can increase the employment of people with disabilities, this does not prove that mandatory accommodation can do so. Burkhauser et al. (1992a) provide a first glimpse of the impact of accommodation on job duration following the onset of a health condition that affects work. Using retrospective data from the 1978 Survey of the Disabled, they created a sample of 348 men who experienced such a health condition. They found that accommodation by an employer significantly extends the worker's duration on the job and that increases in the replacement rate decrease it. But they caution that accommodation is not likely to have been assigned randomly, so their results are likely to be biased upward. At present, no studies have looked into what factors influence who is accommodated.

Summary of the Disability Literature

The decision to apply for disability benefits is not determined by health conditions alone. In most European countries, the eligibility criteria permit those with only partial disabilities onto the rolls, so that a person's earning capacity is considered in determining benefits. In the United States, only those who are unable to perform any "substantial gainful activity" for at least a year are eligible to be admitted to the Social Security disability rolls. The dramatic rise and fall in application rates and in the disability insurance population over the past two decades in Europe as well as in the United States leave little doubt that forces besides health are at work.

Aggregate U.S. data provide strong prima facie evidence that increasing benefits and easier access to them in the 1970s increased the population describing itself as work-impaired, as well as the population that applied for and received benefits. Reduced access appears to have reduced these populations in the 1980s. But providing sophisticated empirical evidence of the precise relationship between disability policy and labor force participation decisions has been difficult.

It is even more the case here than it is for retirement that better data on health and economic variables are needed to estimate the work effort of those whose health limits their ability to work. Yet most of the data sets used in this literature lacked sophisticated health information. Only the 1972 and 1978 Surveys of the Disabled provide detailed information on both health and economic variables.

[24] In Germany, for example, all firms must employ one worker with a disability for every 16 employees. The penalty for noncompliance is relatively low (200 deutsche marks —about $125 per month), and only about 4.5 percent of the German work force has disabilities, as defined by the program.

The recent passage of the ADA makes it even more important to recognize that the transition to disability is a process. For this reason, the timing of policy interventions to encourage work is important. Substantial time may elapse between the onset of a health condition, its first impact on work performance, job exit, and application for disability benefits. Furthermore, applying for disability benefits is a risky gamble whose outcome can be delayed for some time. Longitudinal data will be needed to trace this process and to disentangle heterogeneity effects from "scarring" effects on the work behavior of rejected applicants.

Fortunately, the new Health and Retirement Survey (HRS) offers hope for multiperiod analysis of the work behavior of people with disabilities. In the short run, the retrospective studies of the labor force withdrawal of those with health conditions that used the 1978 Survey of the Disabled can be redone and expanded with retrospective information contained on the first wave of the HRS. This wave also contains detailed information on types of accommodation provided by firms. In the longer run, the onset of a health condition will be captured in future waves of the data. The detailed information that the HRS will contain on firm-specific retirement plans, combined with matched information on Social Security records, should allow detailed analyses of the disability and retirement issues raised in this chapter.

FUTURE TRENDS, AND RESEARCH AND DATA NEEDS

Recent labor force statistics suggest that the trend toward earlier labor force withdrawal may have stopped in the United States. The hours worked by employed older Americans, however, may still be on the decline, since the percentage of the elderly working part-time continues to increase. Changes are currently under way in both the public and the private sectors that will influence future retirement decisions by altering the work disincentives faced at older ages. Although the direction of the impact of some of these changes is clear, a significant unknown remains—whether private sector defined benefit pensions will go along with Social Security and reduce their work disincentives or, alternatively, whether they will increase their work disincentives to make up for the loss of the Social Security effect.

Mandatory Retirement Provisions

Mandatory retirement rules once covered about half of the working population in the United States. Prior to 1978, the most common mandatory retirement age was 65. The 1978 amendments to the Age Discrimination in Employment Act made age 70 the earliest possible mandatory retirement age for most American workers, and in 1986, the upper limit at age 70 was removed, eliminating mandatory retirement for the vast majority of American workers. One notable exception to the ban was made for colleges and universities, who were permitted to continue mandatory retirement at age 70 for tenured faculty. This exception expired in January 1994.

Since many workers used to retire at age 65, casual empiricism suggested that mandatory retirement was an important factor in the decision. But simple correlations can be misleading. Parnes (1988) found that in a large sample of American men who had retired by 1981, there were only 3 percent that were covered by mandatory retirement who actually retired at that age and who said that would have preferred to work longer. Burkhauser and Quinn (1983b) emphasized that age 65 was also the age at which important Social Security and employer pension retirement incentives went into effect, and estimated that at least half (and probably more) of what looked like a mandatory retirement effect was actually due to concurrent financial incentives.

The elimination of mandatory retirement did not have large aggregate effects. The stick was removed, but the carrots remained. Nonetheless, this change has and will continue to extend the work life of certain individuals. It may also change the workplace environment and discourage the idea that there is some best age for everyone to retire.

Social Security

A number of changes have occurred and are planned that will increase the rewards for work by older Americans and thereby encourage them to remain longer in the labor force. Whether this will occur on their career jobs or on subsequent bridge jobs will depend on other factors, particularly future changes in private pension incentives.

The Social Security earnings test has already been liberalized for those aged 65-69. (It disappears entirely at age 70, which was 72 prior to 1983.) Since 1978, the earnings that recipients are allowed before benefits are reduced have been higher than for those aged 62-64 ($11,160 versus $8,040 per year in 1994), and in 1990, their benefit reduction rate on earnings over the exempt amount was decreased from one-half (which it remains for those 62-64) to one-third. There has been discussion of eliminating the earnings test all together. The Congressional Budget Office has estimated that its elimination would cost about $6 billion per year (only 10% of which would be made up in increased taxes) and would disproportionately help those already better off than average (U.S. Congress, 1992:21). Research suggests that this would have only modest labor supply effects (Leonesio, 1990; Gustman and Steinmeier, 1991).

Other Social Security amendments are also increasing the reward for continued work. Since 1989, the delayed retirement credit (DRC) has in creased from 3 to 4 percent for each year's delay of benefit receipt beyond the age at which "full benefits" (100% of the Primary Insurance Amount (PIA)) are paid. The DRC will continue to increase by 0.5 percent every other year until it reaches 8 percent in 2010. This will be close to actuarially fair and will make Social Security approximately age-neutral; that is, the present discounted value of the benefits will no longer depend significantly on when they are first claimed. [25] This will effectively eliminate the earnings test, since benefits forgone by earnings above the exempt amount will be returned through higher benefits later.

The age of "full benefits" is also scheduled to increase from 65 to 66 between the years 2000 and 2005, and then from 66 to 67 between 2017 and 2022. Although these changes are usually described as a shift of the DRC curve to the right (one has to wait longer to receive 100 percent of one's Primary Insurance Amount), they are just as accurately described as a shift down—lower benefits at any age, or an across-the-board decrease in benefits. These benefit declines will lower retirement wealth and should also, at the margin, delay retirement.

Several analysts have simulated the impact of these Social Security changes (Fields and Mitchell, 1984a; Burtless and Moffitt, 1984; Gohmann and Clark, 1989; Gustman and Steinmeier, 1985, 1991; Stock and Wise, 1990). All agree that these will be in the expected direction, but that they will be modest—on the order of months, on average, not years. Most analysts think that pension changes are potentially much more important.

Employer Pensions

Several important trends are under way among employer pension plans. The first is that pension coverage among American workers is no longer growing. According to Turner and Beller (1992), the percentage of private sector workers who are active participants in an employer pension plan was constant from 1970 to 1987. More recent evidence suggests that coverage may be declining. Woods (1989) estimates that among full-time private wage and salary workers, coverage peaked at 50 percent in 1979 and dropped to 46 percent by 1988.[26] Short and Nelson (1991) report a slight drop in

[25] As Gustman and Steinmeier (1991) point out, however, a common delayed retirement credit cannot be actuarially fair for all, since different demographic groups have different life expectancies.

[26] Korczyk (1993) and Reno (1993) both note that whereas pension coverage has been declining for men (from 54 to 49% of full-time male workers between 1972 and 1988), it has been increasing (from 38 to 43%) for women working full-time over the same period. Pension coverage is still more common among male workers, but the gap is narrowing.

Pension receipt (which is different from coverage) differs dramatically by race. Snyder plan participation between 1984 and 1987. Reno (1993), piecing together statistics from a number of sources, shows that coverage grew rapidly from 1940 (12% of private sector employees) to 1960 (38%), continued to expand slowly though the 1960s and 1970s (reaching 43% in 1979), and then declined to 40 percent by 1988.[27] Since workers with pension coverage are more likely to retire early, a decline in coverage may contribute to delayed retirement (Quinn et al., 1990:195-200).

In addition, the relative importance of defined benefit and defined contribution plans is changing. Only the former contain the work disincentives emphasized above. The latter are really just savings accounts with tax advantages and are by their very nature age-neutral. The proportion of pension participants whose primary coverage is defined contribution increased from 13 to 32 percent between 1975 and 1987 (Turner and Beller, 1992).[28] In addition, supplementary coverage (a second plan offered by the same employer) has increased, from 21 percent of covered workers in 1975 to 39 percent in 1987, and this is almost entirely defined contribution.[29] Overall, with double counting of those covered by more than one plan, the proportion of active participants in defined contribution plans rose from 29 to 65 percent during the decade ending in 1987 (Turner and Beller, 1992).[30] If this trend continues, strong and effective work disincentives will become less widespread, inducing less early retirement.

At the same time, however, defined benefit plans, which still provide

(1993) estimates that in 1982, 57 percent of married white men received some pension income, compared to 44 percent of blacks and 35 percent of Hispanics. For married women, analogous numbers were 36, 24, and 30 percent; for unmarried men and woman, 29, 15, and 16 percent. There is evidence that the gap is closing, since the growth in pension receipt between 1970 and 1982 was much higher for blacks than for whites (111 versus 51% for men; 300 versus 72% for women). The median pension amounts received by those with pension income differed little between whites and blacks (Snyder, 1993).

[27] Some of the discrepancy in the coverage estimates is due to the different populations being discussed. Reno (1993:Table 8) shows estimates for 1979, 1983, and 1988 for all private sector wage and salary workers (40% in 1988—this is Reno's population), full-time private wage and salary (46%—Woods' population), part-time private wage and salary (9%), government employees (75%), the self-employed (21%), and all workers (44%).

[28] Gustman and Steinmeier (1992) estimate that about half of the change from defined benefit to defined contribution coverage is due to shifting employment mix as American job growth shifted from large, unionized manufacturing firms to smaller, service-oriented nonunion employers who have always been more likely to offer defined contribution plans.

[29] Nearly all of these supplementary plans are profit-sharing or thrift-savings programs, like 401(k) plans. In 1987, about 56 percent of these supplementary plans were funded entirely or partly through employee contributions (Turner and Beller, 1992:71 and Table 4.14).

[30] Paine (1993) thinks that the trend toward defined contribution (DC) plans will continue both because future sources of employment growth are likely to be in smaller firms and in service industries (each of which prefers DC plans) and because global competition will reduce firms' willingness to offer long-term promises based on future wage increases.

the majority of primary coverage, have continued to move toward permitting and encouraging early retirement. Wiatrowski (1990) reports that nearly all defined benefit plans now include early retirement provisions and that fewer than one-fifth of those eligible face full actuarial reductions in annual benefits if they retire early. Mitchell (1992) estimates that 60 percent of defined benefit participants could retire at age 55 in 1980; by 1989, that figure had risen to 66 percent. The proportion requiring only 5 years of service at age 55 to be eligible rose from 5 to 9 percent; those needing 10 years at age 55 rose from 36 to 43 percent. Only half as many people needed 30 years of service in 1989 as in 1980 (5 versus 9%).

One policy change in the other direction was 1986 legislation that required employers to continue contributions and credits toward pension accrual for workers who work beyond normal retirement age, up to the maximum number of years permitted (Mitchell, 1992). Previously, credits could cease at this age, usually 65. This will increase total compensation for some older workers and may induce some to delay retirement.

One great unknown on the retirement horizon is how employer pension incentives will evolve. Mandatory retirement is gone, and strong Social Security retirement incentives are being phased out. Will employers go along with this trend toward an age-neutral workplace and diminish their work disincentives as well? Or will they try to make up for the loss of the stick (mandatory retirement) and part of the carrot (the Social Security incentives) by increasing the penalties they impose on those who stay on the job too long?

There is evidence that employers have bucked the trend in the past. Mitchell and Luzadis (1988; and Luzadis and Mitchell, 1991) analyzed the incentives in some specific private pension plans over time. They found that during the 1970s, when the earliest legal mandatory retirement age was changed from 65 to 70 and momentum for eliminating it altogether was increasing, "the companies with plans that enhanced early retirement incentives by 1980 were the same companies that had made retirement mandatory at a relatively early age in 1970" (Mitchell and Luzadis, 1988:107). In these firms, the carrot replaced the stick. More recent data suggest that this trend toward offsetting prowork policies with higher rewards for job exit is continuing. As discussed above, Mitchell (1992) finds that defined benefit plans tended to encourage earlier and earlier retirements during the 1980s.

How firms will react in the future to Social Security's move toward age-neutrality is likely to depend on future labor markets. If labor shortages do develop, as demographic projections suggest they might, then firms may alter their pension plans to encourage older workers to remain on the job. These incentives have been effective in one direction in the past, and there is no reason to believe that they cannot be equally effective in the other direction as well.

Data Needs

The dramatic increase in retirement research in the 1980s was in part a response to the policy questions surrounding the short- and long-term Social Security budget crises. But this research would not have been possible without the existence of two large longitudinal microeconomic data sets first fielded in the 1960s—the Social Security Administration's Retirement History Study[31] and the Labor Department's National Survey of Older Men.[32]

These outstanding data sets contained large representative samples of older Americans and a wealth of demographic, social, economic, and financial data on each respondent. In addition, Social Security internal records were appended, including information on past earnings and precise measures of potential Social Security benefits. A major drawback of both, however, was the paucity of details on employer pension plans. Employer pensions are complex agreements, and these data sets did not begin to capture the subtleties of the individual plans. And they contained even less information on other fringe benefits such as health care.

As it became clear that detailed information on employer pensions was necessary to understand the retirement decisions of older workers, researchers turned to other sources. The Department of Labor's 1983 Employee Benefit Survey of Medium and Large Firms includes specific benefit calculation rules missing from the microdata sets.[33] But these data did not represent the entire pension population, and lacked most of the other demographic and economic information on individuals found in the RHS and NLS.

In a series of papers, Wise and his colleagues have used detailed information on individuals gathered from a few corporations (Kotlikoff and Wise, 1989; Stock and Wise, 1990; Lumsdaine et al., 1992). These firm-specific data have proven extremely valuable in tracing the accrual patterns of pensions and the way in which workers respond to them. Unfortunately, they contain almost no information on the workers other than wage history. Hence, they are not useful, for instance, in disentangling economic incentives from the effects of poor health on the retirement decision.

One data set that attempts to merge information on specific pension plans with socioeconomic data on a representative sample of workers is the 1983 Survey of Consumer Finance, which surveyed a random sample of

[31] The RHS surveyed a cohort of more than 11,000 men and nonmarried women aged 59-63 in 1969 and every other year thereafter through 1979. For a detailed discussion of the data set, see Irelan (1976).

[32] The NLS followed a cohort of about 5,000 men aged 45-59 in 1966 from then until 1983. For a detailed discussion of this data set, see Parnes et al. (1985).

[33] See Fields and Mitchell (1984c), and Allen et al. (1986a) for a discussion of these data.

4,200 households in 1983. Since then, two follow-up surveys on this population have been fielded. What made this an innovative data set was that it also surveyed the respondents' employers to obtain pension plan details. Because it is a survey of wealth holdings across the entire age distribution, however, it has only limited value for studying the retirement decision. Another problem is that the detailed information on pensions proved extremely difficult for researchers to access and therefore has been used sparingly.

For these reasons, during the 1980s and into the early 1990s, the data set of choice for retirement questions continued to be the RHS, even though most of its respondents left their career jobs in the early 1970s. The lack of data on more recent cohorts has severely restricted our knowledge of how the retirement process is currently operating.

The new Health and Retirement Study will go a long way toward correcting this situation. This longitudinal study, funded under a cooperative agreement with the National Institute on Aging, surveyed approximately 8,000 households with one or more respondents aged 51-61 in 1992. It will provide detailed information on the health and economic behavior of this cohort as it makes the transition into retirement in the mid-1990s.

The HRS will prove to be an important resource for researchers in the 1990s because it is newer and because it combines better information on health with more detailed information on economic characteristics. It will also contain employer data on pension and health insurance, along with Social Security earnings records, and has the potential to link other SSA records such as Supplemental Security Income and Social Security benefits. Unlike the RHS, the study design includes a random sample of women aged 51-61 and an oversampling of blacks, Hispanics, and residents of areas with high numbers and densities of older people.

No prior longitudinal data sets have contained the quality of information on health and economic behavior that will be available in the HRS. Prior data sets with high-quality health data such as the National Health Interview Survey, have contained very little information on economic behavior and none on pensions. Hence, they have only rarely been used in studies of retirement or disability insurance acceptance (see Bound and Waidmann, 1992, for an exception).

The best data sets for evaluating the effect of a health condition on work have been the 1972 and 1978 Social Security Surveys of the Disabled. Unfortunately, budget cuts in the 1980s ended this periodic cross-sectional survey. Hence, those interested in evaluating the effect of disability programs on the economic well-being and behavior of workers with health conditions are forced to use this badly out-of-date information (Bound 1989; Haveman et al., 1991; Burkhauser et al., 1992a,b).

The HRS will be very useful for studying the influence of socioeco nomic factors on job exit and application for disability benefits. The first wave has a module containing retrospective questions on respondent's health that parallels the questions in the Survey of the Disabled. These responses will provide information on transitions from work for those in the cohort with a current health condition. In the longer term, the full benefits of a longitudinal data set will enable researchers to follow the outcomes of older workers who experience a decline in health in the 1990s. These data will be particularly useful for those interested in estimating the impact of the Americans with Disabilities Act of 1990. This act, which was fully implemented for firms with 25 or more workers in 1992, requires that all such firms provide reasonable accommodations to people with disabilities as long as this does not put an undue burden on the operation of the business. The HRS will allow researchers to study the accommodation experiences of older-age workers following the onset of a health-related work impairment in the 1990s. Such data will in part offset the major data loss caused by the curtailment of the Survey of the Disabled. But it is not a substitute for investigating the labor force participation rates of people with disabilities. The need for these data remains unmet.

Comparable international data on the health and economic behavior of older workers have been even more difficult to obtain. But even here some gains have been made. The Luxembourg Income Study contains detailed representative cross-sectional data on the populations of most Western European and several Eastern European countries. The data for each country have been refined so that cross-national comparisons can be made.[34]

Longitudinal data fielded outside the United States have been rarer. Few such studies existed prior to the 1980s. But in the last decade, some new longitudinal data initiatives were begun. The German Socio-Economic Panel (GSOEP) surveyed a representative sample of more than 6,000 German households in 1984 and continues to interview them annually. Eight waves of these data (1984-1991) are now available. These data, similar to the Panel Study on Income Dynamics, can be used to trace the work efforts of Germans over the 1980s. They also contain, beginning in 1990, a random sample of the former East German states that are now part of a unified Germany. The National Institute on Aging has funded a project in cooperation with the Deutsches Institute fur Wirtschaftsforschung (DIW) in Berlin to make the GSOEP available to English-speaking users in a fully translated form through the Gerontology Center, The Maxwell School, Syracuse University.[35] New longitudinal data sets of this type are now being fielded in

[34] For a detailed discussion of these data, see Coder et al. (1991). For an example of the use of these data for retirement research, see Smeeding (1993).

[35] For a detailed discussion of these data see Wagner et al. (1993).

several other European countries—France (Lorraine), the Netherlands, Ireland, Belgium, Luxembourg, and Great Britain—and plans are under way to make these data sets comparable.[36]

All of these new longitudinal surveys contain representative population samples, and some contain enough observations of older persons to analyze labor supply decisions from a multiperiod perspective. But like the PSID in the United States, their primary strength is in measuring economic well-being. They contain information on health similar to that in the RHS. They also contain limited information on employer pension plans. However, this is not as great a drawback for studies of retirement as it would be in the United States because most of these European data sets contain good information on their social security retirement and disability benefits. In European countries, these are the programs that dominate the retirement decision.

A final data collection effort that will help close the gap between the detailed information on health and retirement provided by the new HRS and the PSID-type sample design surveys in Europe is the new Health and Retirement Study in Holland. This is a longitudinal survey of 4,000 households containing persons aged 50-63 in 1993. It is funded by NESTOR, a governmental grant committee especially designed to encourage research on aging in Holland, and by the University of Leiden. This may prove to be an important source for cross-national comparisons of retirement in the United States and Holland.

The major new longitudinal data sets now becoming available in Europe promise a whole new era of longitudinal comparisons of the economic well-being and labor force participation of older men and women. But greater efforts must be made to ensure the comparability of these data sets with each other and with those in the United States.

Investments in data collection begun in the 1960s paid huge dividends in the evaluation of public policy regarding older men during the subsequent two decades. A lack of follow-up in the 1980s retarded research on these issues. The fielding of the HRS promises to close the gap in our knowledge of the influence of labor market institutions on the labor force participation of older men and women. But, like the old RHS, it will require several more years of investment in order to have a major payoff. Today, our most critical data need is the patience necessary to continue funding this major social science project until its longitudinal character is complete.

[36] This project is being funded by the European Science Foundation and run by the Center for Population, Poverty, and Policy Studies (Luxembourg) and the DIW.

SUMMARY AND CONCLUSIONS

The long-term trend toward earlier retirement among men is found throughout the developed world. In some countries, including the United States, the trend may have recently come to a halt. The experiences of older women are more varied and combine the earlier retirement trend with the increased labor force participation of women in general.

Considerable research on retirement in the United States has shown that strong incentives to retire are embedded in many of our public and private retirement systems, and that these penalize workers who stay on their career jobs too long. The mechanism is not the paycheck. Explicit age-related pay cuts would be illegal. Rather, the mechanism is found in pension benefit calculation rules that, at some age (65 for Social Security; various ages for defined benefit employer plans), decrease retirement income wealth for those who keep working. These negative accruals are part of compensation and are equivalent to a pay cut. Many older Americans behave as though they understand and respond to these incentives—the larger the wealth loss associated with continued work, the more likely they are to leave their career jobs. The majority of these retirees leave the labor force as well, but a significant minority move to new employment—bridge jobs—often part-time.

Changes are under way that will decrease these work disincentives and encourage later departure from the labor force. Mandatory retirement has virtually been eliminated. Social Security will become close to age-neutral over the next two decades, and the age of "full benefits" is scheduled to increase from 65 to 67. Employer pension coverage is flat or declining, and the proportion of those covered by defined contribution plans (without the retirement incentives emphasized above) is on the rise. But the majority of covered American workers are still in defined benefit plans, and these continue to exert a very powerful impact on retirement behavior.

As long as these incentives remain, so will the current pattern of labor force withdrawal. Workers will tend to leave their career jobs to avoid reductions in their pension wealth, and many will then look for new employment. As Social Security work disincentives disappear, this route will become even more attractive.

Demographic projections, however, suggest that employers may want to change their benefit structures. Industrialized nations are aging. The number of Americans aged 65 and above, about 32 million today, will more than double by the year 2030, while the number aged 55-64 will increase by two-thirds. In contrast, the number under age 18 is projected to decline slightly over the same four decades, and the number of all those under 55 to increase by only 1 percent (Bureau of the Census, 1989; U.S. Senate, 1991). As a result, the percentage of all Americans aged 65 and over is estimated to increase from less than 13 percent today to nearly 22 percent by 2030 (Bureau of the Census, 1989). One-third of the U.S. population will be 55 and older, and the median age will rise from 33 to 42.

Those concerned with retirement finance often emphasize the ratio of the prime working-age population (aged 18-64) to those of traditional retirement age (65 and over). This ratio, about 5 to 1 today, will drop to less than 3 to 1 by 2030. But 65, as we have seen, is no longer the typical age of retirement. When the demographic and retirement trends are combined— more older Americans, and fewer of them working—the projections are even more dramatic. Aaron et al. (1989) estimate that the ratio of Social Security contributors to Social Security beneficiaries will drop from 3.3 to 1 today to only 2 to 1 by 2030.

But there is no reason to assume that current retirement patterns must or will continue. Research has shown that retirement decisions are endogenous. People make choices based on the financial incentives they face. These incentives have been changed in the past, to encourage early exit from the firm, and they can be changed again, to do the opposite. Such changes will occur when it is in employers' interests to keep older workers on the job. Predicting future labor markets is a risky business. What we can predict with confidence is that if these shortages develop, and if firms decide that the retention of experienced workers can help alleviate the shortages, then the policy tools exist to keep older workers on the job.

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4

Income, Wealth, and Intergenerational Economic Relations of the Aged

Douglas Holtz-Eakin and Timothy M. Smeeding

INTRODUCTION

This chapter summarizes what is known about the economics of the aged. In doing so, our goals are to review the relevant literature and to identify valuable new directions for research into the economic status of the aged in the United States. Our discussion is organized around several themes:

1. the wide diversity in economic status among the U.S. aged compared to the aged in other nations;
2. the recent trends in the economic status of the aged and their sustainability in the foreseeable future;
3. the role of intergenerational transfers in affecting the welfare of the aged; and
4. the data needs for studying the aged, including the potential of the new Health and Retirement Survey (HRS) and Assets and Health Dynamics (AHEAD) survey, which are in their initial stages.

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Our discussion of several topics is limited by the constraints of space and data. In particular, housing choice and mobility, the separate identification of period or cohort effects on the economic status of the aged, and the baby boom's retirement prospects are given less space than their importance might suggest.[1] Predicting the economic status of the aged at the turn of the century is, in our opinion, a speculative venture; forecasting the economic status of the aged well into the next century is even worse (Smeeding, 1991; Palmer, 1988). In fact, the data resources needed to make such judgments as these are just now beginning to be collected and analyzed.

This chapter is divided into four substantive parts. The next three sections deal with income (and consumption) and poverty, wealth, and intergenerational economic relations, respectively. In the final section we turn to the implications of our results for additional research and data needs in this area.

ECONOMIC WELL-BEING: INCOME, POVERTY, AND CONSUMPTION

The purpose of this section is to review what we know about the economic circumstances of the old, with economic welfare largely measured by their incomes. Comparisons are made both over time and across countries regarding the poverty and affluence of the aged. In order to present these materials in a comprehensive way, we concentrate on income comparisons that provide the single best widely available measure of economic status at a point in time or over time. Other valid and important measures of economic status, such as consumption, are discussed. Our treatment is, however, more circumscribed because of space and data limitations.

There are a variety of income concepts available to applied researchers, but economists have traditionally relied on disposable personal income as the most important indicator of economic well-being for an individual. Cross-sectional, survey-based money income data are regularly available to researchers. Less readily available, but increasingly useful, are longitudinal "panel" microdata sets that permit researchers to follow individuals and their changing economic circumstances over time. In the United States, the leading examples of the latter are the Michigan Panel Study of Income Dynamics (PSID) and the National Longitudinal Survey (NLS). Data from the Luxembourg Income Study (LIS) project allow for cross-sectional comparisons among several industrial democracies at two points in time (early

[1] For instance, the choice of housing and living arrangements among elderly widows has important interactions with economic circumstances and measured well-being; see Macunovich et al. (1992).

and middle 1980s). More recent is a project that combines the PSID with the German Socio-Economic Panel (GSOEP), permitting for the first time cross-national comparisons of panel data.

Although money income is a useful measure of economic well-being, it serves largely as a proxy for the variable of ultimate interest: final consumption. To convert income estimates into consumption estimates, we need to take account of three factors. First, economic responsibilities and needs can vary substantially among families, depending on their characteristics, particularly the number and age of family members. Second, many resources of considerable economic value—for example, home ownership and medical insurance—affect consumption but not money income. Thus, two families with similar money incomes could, in fact, have very different levels of economic well-being, and two families that might generally be judged as having a similar level of economic well-being might have very different levels of money income. Third, current income may rise above or fall below long-run, or permanent, income. Savings or transfers may cushion consumption from these shocks and weaken the relationship between current income and current consumption. The first two of these limitations can be overcome at least in part by trying to estimate the income value of nonmoney economic resources and by adjusting measures of income to reflect differences in needs by using adult "equivalence scales." The adjustment is made by dividing the income of a given size and age unit by the relative number of equivalent adults, normalized, for example, to a family of size three.

Changes in U.S. Means and Medians

The increased well-being of the elderly as a group over the past 20 years is now a well-documented fact. In 1991, the median income of households with a head aged 65 and older before taxes was $16,975—a gain of more than 40 percent in the purchasing power of this group since 1971[2] (Bureau of the Census, 1992a:Table B-4). Moreover, the 1991 median income was more than twice the level of the poverty threshold for an elderly couple ($8,241) (Bureau of the Census, 1992c).

Since 1980, the elderly have experienced both a faster increase in average money income and a faster reduction of official (income-based) poverty

[2] Unless otherwise stated, all measures are deflated using the Consumer Price Index, Urban Consumers (CPI-Uxl) price index. The terms household and family are used separately here. A household includes all persons sharing the same arrangements whether related or not. A "family" is all persons living together and related by blood, marriage, or adoption. The terms are used as prescribed by the data sources.

than have the nonelderly (Radner, 1987, 1992; Bureau of the Census, 1992a; Duncan and Smith, 1988; Hurd, 1990; Smolensky et al., 1988). In large part, the increased relative position of the elderly is due to the slow growth in incomes of working families, and to the automatic wage indexing of initial benefits and price indexing of existing benefits in the Old Age and Survivors Insurance Program (OASI). Most of this gain took place by 1985. By 1991, real median household money income was below the 1986 value for householders both over and under age 65, though it fell by more for the nonaged (2.7 percentage points) than for the aged (1.3 percentage points) (Bureau of the Census, 1992b). Income gain for the elderly relative to the nonelderly was not a phenomenon unique to the United States. In fact, it occurred to an equal or greater extent in Canada and the United Kingdom (Smeeding et al., 1993).

A recent report (Bureau of the Census, 1992a) allows one to make comparisons between the elderly and the entire population using a broader definition of income. "Expanded" income is money income including capital gains, plus fringe benefits, in-kind transfers, and implicit rent, minus rent paid. Because the income distribution for both elderly and nonelderly is skewed, mean (or average) household income is higher than median household income. For instance, census cash income for all households with members age 65 or over had a mean value of $26,408 in 1991, but a median value of $18,183 (Bureau of Census, 1992a:Table 1, p. 51). Thus, medians allow us to compare the "middle" unit (family or household) in the distribution of the elderly to its counterpart among the nonelderly, whereas means measure the average position regardless of the shape of the distribution.

Comparisons of income for the elderly to income for the entire population based on these data are presented in Table 4-1. They indicate that on an expanded income basis, by adjusting for differences in household size, the mean and median ratios of incomes of households with elders to incomes of all households are 1.05 and 1.02, respectively.[3] In other words, on this basis, the elderly *as a group* are now as well off as are the nonelderly, *as a group*.

One of the most comprehensive studies of trends in family incomes since 1970 was recently completed by the Congressional Budget Office (CBO, 1988). Using an equivalence adjusted family income (AFI) measure, CBO finds that median incomes for all families (and unrelated individuals) grew by about 20 percent over the 1970-1986 period. Although the CBO was unable to include taxes or income in kind in its computations, [4] the

[3] Excluding the imputed return on home equity, these ratios are 0.99 and 0.95, respectively. See notes in Table 4-1 for a complete description of the income definitions.

[4] The effects of taxes and in-kind transfers would be to increase the rate of growth of elder family median incomes relative to nonelderly family incomes over this period.

differences in income growth among various groups are striking. Elderly childless families (largely married couples) and unrelated individuals experienced large (nearly 50%) increases in real income. (The latter group started from a much lower base.) Much of the rapid growth in income among the elderly is directly attributable to increased OASI benefits. Among all retired Social Security recipients, on average, real benefits rose from $3,730 in 1970 to $5,856 in 1986, an increase of 57 percent (Congressional Budget Office, 1988). Families with children did less well, experiencing a 13 percent increase in incomes, with all of this increase taking place by 1979. Since then, real incomes have stagnated for this group. By 1986,

TABLE 4-1 Ratios of Incomes of the Elderly (households with persons 65 and over) to Incomes of All Households in 1979 and 1991

	Unadjusted for Size of Household		Adjusted for Size of Household[a]	
Income Concept	1979	1991	1979	1991
Ratios of means				
Money income before taxes[b]	0.64	0.70	0.77	0.85
Expanded income[c]	0.73	0.81	0.86	0.99
Expanded income plus implicit rents[d]	0.76	0.86	0.90	1.05
Ratios of medians				
Money income before taxes[b]	0.52	0.60	0.62	0.74
Expanded income[c]	0.65	0.78	0.78	0.95
Expanded income plus implicit rents[d]	0.72	0.83	0.86	1.02

[a] Adjusted incomes were computed by using the Census Bureau's poverty line equivalence scale to transform unadjusted income. The average household size for all families was 2.63 persons as compared to 1.65 for all households headed by a person 65 and over in 1991. In 1979, the values were 2.78 for all households and 1.88 for households headed by a person 65 or over.

[b] Money income before taxes is the traditional Census Bureau's measure of income used to generate annual income and poverty statistics.

[c] Expanded income adds realized capital gains, employer-provided fringe benefits in the form of health insurance, noncash transfers in the form of health insurance (Medicare, Medicaid), food stamps, and public housing. It also subtracts federal and state income taxes and payroll taxes. Medicare and Medicaid are measured at their fungible value (i.e., they are counted as income only to the extent that they free up resources over and above basic food and housing requirements that could have been spent on health care). See Bureau of the Census (1992a:B-1 to B-5, C-1 to C-4), for full explanation.

[d] Expended income plus implicit rent adds a measure of the implicit rental income of owner occupiers via a rate of return (6.9% in 1991) applied to the net equity in owned homes. It also subtracts property taxes owed on these homes from the expanded income measure defined in c above. See Bureau of the Census (1992a:B-3, B-4) for full explanation.

SOURCE: Based on data in Bureau of the Census (1992a).

childless elderly families had AFIs that were substantially higher than those for families with children.

Variation in Well-Being

Despite these impressive gains on average, the key factor to be emphasized in investigations into the economic status of the elderly is their heterogeneity. Quinn (1987:64) captured the essence of this argument as well as anyone:

> ... never begin a sentence with "The elderly are ..." or "The elderly do ..." No matter what you are discussing, some are, and some are not; some do, and some do not. The most important characteristic of the aged is their diversity. The average can be very deceptive, because it ignores the tremendous dispersion around it. Beware of the mean.

In particular, a major contributor to the rising average economic status for the elderly over time is the very fact that the group is changing. "New entrants" to the elderly group (those persons in households or families headed by a person just turning age 65) arrive with higher average income and wealth than persons leaving that group (those who die in any given year). For instance, comparing data from two Census Bureau surveys, the first taken in 1979 and the second in 1984, the average income and net worth of those families with heads aged 65-69 increased by 47.5 and 37.6 percent, respectively, over this 5-year period (Lamas and McNeill, 1985). On the other hand, the incomes and net worth of those families with heads 65 to 69 in 1979 who were aged 70 to 74 in 1984, increased by only 13.5 and 14.4 percent, respectively. Although this trend may someday change (Levy and Michel, 1991), over the past two decades, average household (or family) incomes increased at a faster rate for the elderly as a group than for a specific cohort of elderly household heads over time.

Ross et al. (1987) indicate that between 1950 and 1980, successive cohorts of the elderly (families with heads age 65 or over) had increasingly higher ratios of unadjusted money income to needs at age 65.[5] But their data also indicate a decrease in income relative to needs for each of these cohorts as it ages (Duncan and Smith, 1988). Using panel data from the PSID to follow a sample of elderly families from 1969 to 1987 (and beyond) indicates that the ratio of income to needs falls after retirement for elderly couples in general and for widows in particular (Burkhauser and Duncan, 1988, 1991). For instance, over the period 1969-1979, older per

[5] Needs are measured by the official poverty line for the correct age and family size group. Alternative needs adjustors (equivalence scales) might provide different results. See Buhmann et al. (1988).

sons who remained intact as married couples throughout the period experienced a drop of 23 percent in their ratio of money income to needs between 1 year prior to retirement and 2 years after retirement. The income-to-needs ratio for this same group fell by another 27 percent during the next 6 years, leaving the average retired couple just 50 percent as well off 8 years after retirement as they were 1 year prior to retirement. The situation is worse for female survivors (eventual widows) but not for male survivors (widowers) of retiring couples over this period: 7 to 8 years after retirement, a widow's income-to-needs ratio is only 40 percent as high as that of the preretirement couple. The lesson to be learned here is that when explaining trends in the economic status of the aged, it is important to differentiate across types of studies (panels, cross section), types of units (widows versus widowers versus couples), and age groupings (cohorts).

Poverty

Perhaps the most noteworthy accomplishment of the past 30 years is the large and sustained decrease in poverty among the U.S. elderly. Two useful points of comparison for the elderly in this context are the changing poverty status of children—the other major dependent group in society—and the poverty status of nonelderly adults. Figure 4-1 presents estimates of the percentage of persons defined as officially poor by the U.S. government. The figure indicates that poverty rates for elderly Americans have fallen, while those of children (as measured by the incomes of families with children) have increased since 1969. In fact, poverty rates of the elderly have been lower than those of children since 1974, and lower than the overall national rate since 1983 (Preston, 1984). For the past 8 years, poverty among the aged has moved in line with poverty among other groups. In 1991, elderly poverty was at 12.4 percent (up slightly from the 11.4% rate recorded in 1989 and less than half of the 1969 rate of 25.3%), while that of children was 21.8 percent (slightly below the 22.3% high of the 1969-1987 period, recorded in 1983, but one-third greater than the 13.8% rate of 1969). The poverty rate of the aged still exceeds that of nonaged adults by about 1 percentage point (see Figure 4-1 and Bureau of the Census, 1992c).

A more detailed picture of poverty among the elderly reveals a diversity of poverty experiences across subgroups (Table 4-2). The overall poverty rates for the elderly shown in Figure 4-1 fail to capture the fact that among the elderly, poverty rates run from a low of 5.3 percent for elderly married males to a high of 21.4 percent for widowed females 65 and older (U.S. Congress, 1992:1240; Bureau of the Census, 1992c). They also do not convey the fact that the poverty rate for black and/or Hispanic aged (who are 20% of the aged today and will be a much higher fraction in the next century) is two to three times higher than that for non-Hispanic whites (the exact figure depends on the category selected; Taeuber, 1992). For instance in 1990, poverty among non-Hispanic white females age 65 and over was 13.3 percent, but 39.3 percent for black females and 24.5 percent for Hispanic females (Bureau of the Census, 1992c:Table 5).

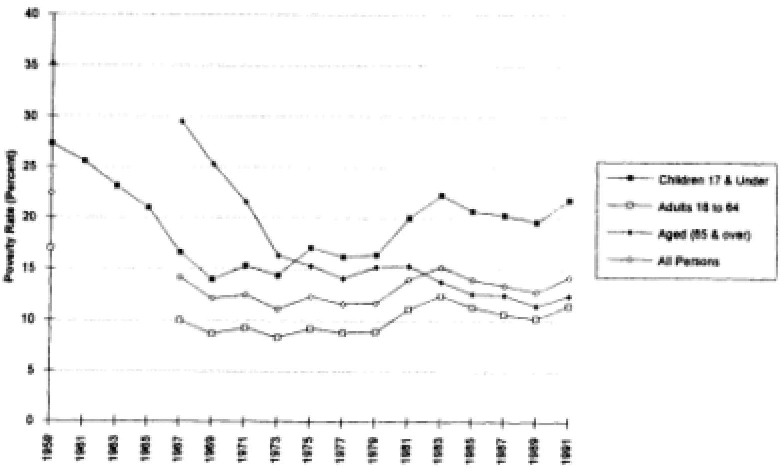


Figure 4-1
Trends in official poverty rates among aged, nonaged adults, and children.
SOURCE: Bureau of the Census (1992b:Table 2, 3). Official poverty rates for persons are derived from the before-tax money incomes of the families in which they reside.

In the same way, elderly poverty rates vary by age. The data in Table 4-2 indicate the relationship between age and the poverty status of elderly persons. With the exception of widowed men, poverty rates among the elderly increase with age. Because elderly persons aged 85 and over are the fastest growing age group in the nation, and these persons are 62 percent female (Taeuber, 1992:Table 2-4), this pattern suggests some cause for concern. In any event, the considerable diversity in poverty experience among the elderly needs to be recognized by those who would draw policy implications from comparisons of overall poverty rates.

In contrast to income-based measures of economic status, following specific persons in families over a 10-year or longer time period yields a similar picture for changes in poverty status (Burkhauser and Duncan, 1988, 1991; Burkhauser et al., 1991). For instance, 35-41 percent of elderly women were likely to be poor at least once between either 1969 and 1979 or 1983 and 1988 as compared to 20 percent of women age 25-45. This same body of research suggests that widowhood is a major source of economic insecurity among aged women in the United States (Burkhauser and Duncan, 1991). In fact, using a longer-term measure of poverty, these researchers find that a higher proportion of aged women are liable to remain poor over several years than are any other age group in the population. Interestingly, the transition to widow status for women is much less well protected than is the equivalent transition to widowerhood for men. Although these panel data studies are quite suggestive, they are hampered to some extent by relatively small samples of the aged.

TABLE 4-2 Poverty Rates Among Subgroups of the Elderly in 1991 (in percent)

Category of Elderly	All 65+	65-74	75-84	85+
Total	12.2	9.7	14.9	20.2
Males, total	7.6	6.4	9.3	12.6
Male, married	5.3	4.2	7.2	11.4
Male, widowed	13.8	13.2	14.3	13.9
Females, total	15.4	12.3	18.3	24.1
Female, married	5.7	4.7	8.1	NA
Female, widowed	21.4	19.5	22.1	24.4

NOTE: Estimates show percentage of persons poor in each age group using the same official U.S. poverty measures employed in Figure 4-1; NA indicates that data is not available.
SOURCE: U.S. Congress (1992).

Moving to broader measures of economic well-being, for instance, those used in Table 4-1 that include noncash income, capital gains, imputed rent, and other sources of income, we find lower overall poverty rates—both in absolute terms and relative to the overall poverty rate for the entire population—among the aged. For instance, among those 65 and over, poverty rates can be as low as 6.1 percent once imputed rent is taken into account. This contrasts with a comparable poverty rate of 10.3 percent for the population at large.

Unfortunately there has been little substantive research into the consumption levels of the aged or on consumption-based measures of poverty and economic well-being. A notable exception is Cutler and Katz (1991). Owing particularly to the effect of imputed rent for owned housing or consumption, they find overall poverty rates among the aged in the 4-5 percent range in the 1980s, compared to 8-9 percent rates for the population at large (Cutler and Katz, 1991:Table 14, p. 48). But even when these income measures are used, poverty rates vary by sex, race, and age.

Near Poverty and Needs

The measures of poverty status presented to this point have used various definitions of income, but all have relied on the official U.S. poverty definition in which the "needs" of the aged (and nonaged) are measured by the Orshansky (1965) food multiplier technique developed 30 years ago. "Food times three" adjusted for age and family size differences results in poverty lines for the aged that are 8-10 percent below those of the nonaged and that exclude several important changes in the consumption bundle of the aged since that time (Ruggles, 1990, 1992; Quinn, 1992; U.S. General Accounting Office, 1992). Although little research has focused on this issue, the initial efforts (Ruggles, 1992; Ruggles and Moon, in press; Moon, 1992) indicate that health care expenses of the aged have changed drastically since the 1960s. For instance, the aged now spend a greater share of income on acute health expenses (15%) than they did before the advent of Medicare (11%; see Moon, 1992; Holden and Smeeding, 1990). Even among poor aged households—who are presumably protected by Medicaid as well as Medicare—acute health care expenses exceeded 20 percent of income in 1987 (U.S. General Accounting Office, 1992).

The income value of home ownership to the aged is also open to some question. As we have seen, poverty rates among the aged fall by a third or more when one imputes as income the rental value of home equity (defined as market value minus mortgage owed). The Bureau of the Census (1992b) assigns a 5-6 percent return to the net asset value of owned homes to calculate imputed rent; Cutler and Katz (1991) employ a regression procedure to estimate the rental equivalences and use this value as a replacement for actual expenses on owned homes in their measure of consumption. Because 57 percent of poor, aged, single women are home owners, such an imputation produces a fairly large drop in the poverty rate of this critical group. On the other hand, the U.S. General Accounting Office (1992) calculates that one-half of U.S. aged home owners spend more than 45 percent of their incomes on property taxes, utilities, and home maintenance. Of these factors, the Census Bureau adjusts only for property taxes. [6] Neither study adjusts the poverty needs measure for any of these differences in income definitions. Greater examination of these issues should be a high priority for future research.

Small differences in "needs" levels for the aged make a large difference in measures of poverty because many of the low-income aged were moved only a short distance beyond the poverty line by changes in average OASI

[6] It is not clear exactly how Cutler and Katz treated property taxes, utilities, or home repairs. Different treatments could provide widely differing estimates of imputed values.

benefit levels and benefit increases over the past 20 years.[7] Near poverty among the elderly (those between 100 and 125% of the poverty line) has decreased only slightly since 1970 as compared to the official poverty rate. Among elderly women householders (largely single women living alone) the percentage that is near poor has actually increased slightly (Bureau of the Census, 1992c:Table 6; Smeeding, 1990:Table 19.5). Because the low-income aged rely on Social Security for 70-79 percent of their incomes (Grad, 1992), the level and benefit structure of OASI is of particular importance to them. Interestingly, due to overall low benefit levels and related eligibility hurdles, the Supplemental Security Income (SSI) program—which is designed to help guarantee a minimum income for the aged—now makes up less than 9 percent of the income of the poor aged (U.S. Congress 1992:Table 10, p. 1244). In fact, disabled children under the age of 18 now receive more in annual SSI benefits than do the SSI aged (Social Security Administration, 1992).

There is another important reason for additional research on measuring needs for single, aged individuals as opposed to aged couples. The Social Security (OASI) benefits of a retired couple are reduced when either the husband or the wife dies. The reduction depends on past earnings and retirement ages for each person. The reduction is usually 33 percent, but in the case of spouses each claiming their own benefits, it can be 50 percent. In contrast, the poverty line for an aged single person is only 20 percent less than the poverty line of an aged couple. Owing to the importance of OASI as an income source to low-income widows, a large decrease in OASI can mean a fall into poverty.[8] Research to establish the "correct" equivalence scale is in its infancy but should be pursued vigorously (Hurd and Wise, 1991; Merz et al., 1992; Smolensky et al., 1988).

International Comparisons

Thanks to the research opportunities created by the Luxembourg Income Study and by the PSID-GSOEP comparable panel data project, we are able to compare the elderly and other population groups across countries. The data underlying these comparisons consist of national income survey data sets that have been made comparable by rearranging and reclassifying incomes. The LIS data we employ are for a range of years between 1979

[7] Of course, these decisions are somewhat endogenous since public policies to increase OASI benefits were likely tailored precisely to accomplish this goal.

[8] Smolensky et al. (1988) find that adopting the same equivalence scales for both poverty and OASI would reduce poverty rates among elderly single women by 22-33 percent. Hurd and Wise (1991) find that increasing survivors benefits by 20 percent would reduce poverty among aged older women from 39-20 percent in 1984.

and 1988 (depending on the country). The PSID-GSOEP data cover the 1983-1988 period.

TABLE 4-3 Ratio of Household Adjusted Disposable Income: Elderly Median to National Median[a]

Living Country/Year	All Heads 65 or Older	Married Couples 65 or Older	Single Female Alone 65 or Older
United States (1986)	85	109	62
Australia (1985-1986)	66	70	56
Canada (1987)	80	88	70
The Netherlands (1987)	88	97	82
Sweden (1987)	82	97	73
France (1984)	93	99	86
Germany (1984)	91	103	83
United Kingdom (1986)	77	83	68
Overall Average[b]	83	93	73

[a] Income is adjusted by using the simple LIS equivalence scale, which counts the first person in the household as 1.0 and all other persons as 0.5, regardless of age. Elderly household heads are 65 or older. Hence, a single aged person needs 50 percent of the income of a three-person household, while an aged couple needs 75 percent as much to reach the same standard of living. Ratios of group adjusted household median to overall adjusted household median income are presented.

[b] Simple row averages excluding missing values.

SOURCE: Smeeding et al. (1993).

The first question we attempt to answer is how well off the aged are relative to the average household in a society. Comparisons are made on the basis of disposable income, including all forms of cash income (earnings, private pensions, property income, and government transfers net of income and payroll taxes), adjusted for differences in the size and composition of households by using a simple equivalence scale.[9] Each country's median income for the aged is divided by its counterpart for the entire population (see Table 4-3).

On this basis the U.S. elderly had a relative median income in the middle 1980s that exceeds the average relative median income of the aged of the entire group by only 2 percentage points (85 versus 83%). The aged in France, Germany, and the Netherlands had higher relative incomes. In

[9] This equivalence scale counts the first person in the household as 1.0 equivalent adults and each additional adult as 0.5. Identical calculations using other equivalence scales produce virtually the same results. The "household" definition is consistent across all countries except Canada and Sweden where we are restricted to the family definition.

contrast, U.S. aged couples were the most affluent group by far, owing to their relative youth and the successively higher real economic status of each generation of adults turning 65 (see above). But elderly women living alone in the United States have incomes that are far below the "other country" average, with only Australian single women being worse off.

Measures of "permanent" disposable income for German and U.S. aged over the 1983-1988 period show much the same pattern. Permanent income is estimated as average total income over 1983-1988. Permanent incomes for men in the United States and Germany were 98 to 101 percent of the adjusted mean.[10] However, permanent incomes for women in the United States were only 77 percent of the national average, as opposed to 94 percent for German women (Burkhauser et al., 1992:Table 6).

Poverty rates among the elderly are measured relative to various fractions of adjusted median overall income in each nation in the top half of Figure 4-2. The U.S. poverty lines for single persons and couples are about 41 percent of adjusted median income. So the 40 percent poverty line estimates in Figure 4-2 are close to the official U.S. government poverty estimates. Different fractions of median income (e.g., the 50% median rate that is equivalent to the United States 125% "near poverty" figure) produce different poverty rates in each bar. However, with the exception of Australia, by using 60 percent of the median measure, the United States has the highest elderly poverty rates of the countries studied. Obviously, the diversity of economic circumstances among U.S. aged extends to poverty as well as affluence. Of all the countries studied, the United States does the least adequate job of preventing poverty among the elderly.

The PSID-GSOEP comparisons reveal a similar pattern of cross-national differences. The percentage of elderly women who are ever poor (by using a 50% of adjusted median income poverty rate) in Germany is half that in the United States over 1983-1988. In the same vein, the percentage of elderly women who are poor on a permanent income basis is 28.7 percent in the United States compared to 6.6 percent in Germany (Burkhauser et al., 1992:Table 10).

The LIS data can be extended to examine further the relative poverty of single women (Smeeding et al., 1993:Tables 3 and 4). Table 4-3 displays a very large difference in the United States between the median adjusted income of elderly married couples and the median adjusted incomes of single aged women living alone. A natural question to ask is whether the poverty rates for these groups reflect this difference. In the United States,

[10] Here, comparisons are made using the U.S. poverty line equivalence scales for the United States, and the German social assistance and poverty line equivalence scales for German data.

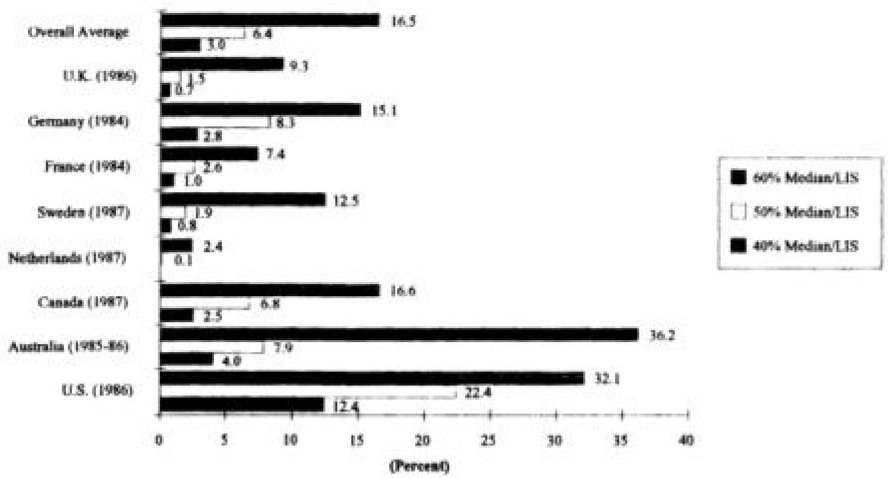
household poverty rates for aged married couples are lower than those for the nonaged population at large, whereas those for single aged women are higher than the average. The difference between the two groups' poverty rates was 11.6 percentage points in 1986, with rates for elderly couples at 6.0 percent and for elderly single women at 17.6 percent. In no other country do we find this same pattern. In every country except Germany (where the differences are small), aged poverty rates—for both single women and couples—are lower than nonaged poverty rates. Hence, elderly single women in the United States are not only the poorest group among the aged, they are also the only group of aged with poverty rates significantly higher than the population as a whole.

Beyond the United States, only in Canada, do we find large positive differences in poverty rates between aged women living alone and elderly couples. However, the differences are much smaller in Canada, and the poverty rates for both groups are below the rate for nonaged persons. In Sweden, the Netherlands, France, and the United Kingdom, poverty rates for both groups are very low and nearly equal. In Australia, Germany, and the United Kingdom, aged single women living alone actually have *lower* poverty rates than do aged couples.

The Safety Net for the Elderly

Every modern country fights poverty among the elderly differently. The floor for income of the aged in the United States is determined by a mix of SSI, OASI, and food stamps, but presumably primary reliance is placed on SSI. The sum of SSI benefits, plus the $20 monthly disregard for OASI or other unearned income, plus the value of food stamps equals 34 percent of adjusted median income for a single aged person, and 37 percent for a couple (see the bottom half of Figure 4-2). These figures are far lower than those found in other nations; the average benefit for all countries is 53 percent for a single person and 59 percent for couples. Many have pointed out that we "patch together" the safety net for the aged in the United States. The key point, however, is that in the aggregate it does not compare to the income support in other nations, even when we incorporate the $20 disregard for unearned income and near cash benefits such as food stamps.

Countries that rely on a means-tested (welfare) approach such as Australia and Canada have higher guarantees. In addition, Canada does not have a wealth (or assets or resources) test, so there are no "income eligible" but "asset ineligible" aged. Australia has only a means-tested system with large asset disregards and a high guarantee. Between 1981 and 1987, Canada instituted a number of reforms aimed particularly at aged single women living alone. These reforms include a higher Guaranteed Income Supplement (GIS is the Canadian equivalent of SSI) with several specific types of



NOTES:

[1] Income is adjusted by using the simple LIS equivalence scale, which counts the first person in the household as 1.0 and all other persons as 0.5, regardless of age. Elderly households are those with heads age 65 or older. Hence a single aged person needs 50 percent of the income of a three person family household, while an aged couple needs 75 percent as much to reach the same standard of living.

[2] Poverty rates are percentage of persons age 65 and over whose household disposable after-tax incomes fall below the specified percentage of adjusted median income. The U.S. poverty line was 40.7 percent of adjusted income in 1986.

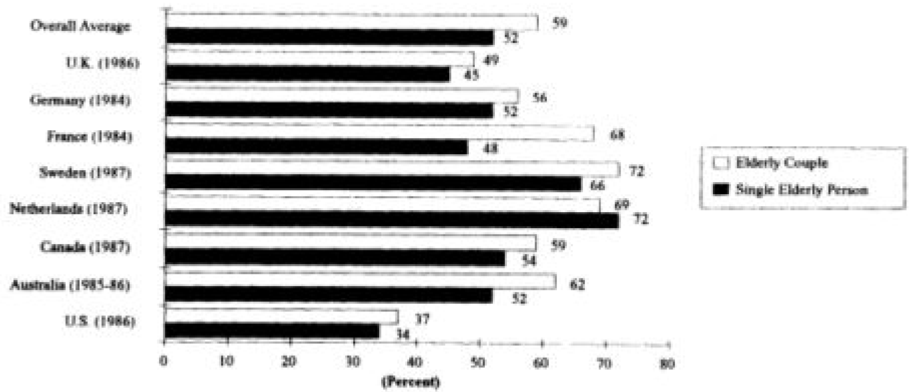


Figure 4-2

Poverty and benefit adequacy among the U.S. elderly in a cross-national context.

SOURCE: Luxembourg Income Study as in Smeeding et al. (1993).

Minimum Old Age Benefit[3] as Percent Adjusted Median Income[4]

NOTES:

[3] Minimum benefits as published by the Organisation for Economic Co-operation and Development (OECD) were compared to adjusted median income after adjusting for national price changes. For the United States, the figures include the SSI benefit, plus the OASI disregard, plus food stamps as indicated in U.S. Congress (1992). For other nations the combination of benefits was determined by OECD. In the Netherlands and Sweden, benefits are adjusted for income taxation. Source: Organisation for Economic Co-operation and Development (1988).

[4] Simple row averages excluding missing values.

income disregards (e.g., veteran's pensions, family allowances) and a 50-percent benefit reduction rate for countable income (which includes Canadian Old Age Social Security benefits, property income, and occupational pensions). As with SSI in the United States, many provinces supplement basic GIS benefits. The net result of these changes was to reduce the poverty rate among Canadian aged women by more than one-half between 1981 and 1987 (Coder et al., 1990; Hanratty and Blank, 1992).

European nations rely mainly on universal social retirement pensions with a relatively high minimum benefit and only a small earnings (or contribution) related second tier. Even the lowest among these, the United Kingdom, has a floor 11 to 12 percentage points above the U.S. minimum benefit. European elderly rely less on occupational (private or public sector, employment-related) pensions and less on asset income than do the U.S. aged. Hence, both low-income aged households and high-income aged households are more scarce in these nations than in the United States.

Summary

A consensus view of those studying incomes among the aged finds them to be on average at par with those of the nonaged, but with a wider variance. Poverty rates among the U.S. aged are lower than those found in the population at large but are high relative to international norms. Although these findings vary slightly, depending on data sets and income measures, they seem robust enough to raise the question: How should the system be modified to ensure adequate income support for the remaining low-income old, especially aged single women, who are rapidly increasing in number and who have historically been at a higher risk of poverty? Related to this issue, research on the income (and consumption) needs of the aged and how they vary between single individuals and couples living alone is sorely needed.

WEALTH

Among the very aged, it can be argued that wealth plays an equal, if not a greater, role than income in determining economic status. We have already seen the effect that imputed rent from the major asset of the aged—their home—has on relative economic status and on poverty. Wealth plays other important roles as well. For instance, the stock of financial wealth—or lack thereof—has an important effect on the flow of income; interest and dividends make up 28.4 percent of the incomes of the nonpoor aged, but only 4.3 percent of the incomes of the poor aged (U.S. Congress, 1992:Table 10, p. 1244). Financial assets also serve as an eligibility barrier to some programs (e.g., Medicaid). Wealth gains provide the wherewithal for the aged to transfer assets to children and grandchildren and for other useful purposes (e.g., vacations, medical bills for acute or chronic health care). The role of asset transfers to and from the aged is the topic of the next section of this chapter. Here we deal with what we know about the distribution and disposition of real assets of the elderly—especially financial, but also nonfinancial, assets and the quality of the available asset data.

Wealth and Its Uses

The 1988 Survey of Income and Program Participation (SIPP) wealth data for the aged present a snapshot of the composition of the net worth of the elderly. Home equity represents about 40 percent of total net worth among those 65 and over. Interest earning assets are 29 percent of the total, whereas rental property, real estates, stocks, and mutual funds are another 17 percent of net worth. The rest (14%) is composed of motor vehicles, boats, and other minor categories. Housing is the most equally distributed asset among the elderly, followed by interest earning assets. Most other assets—rental property, real estate, stocks, bonds, mutual funds—are concentrated among the high-income and high-wealth households headed by an elderly person.

Economic theory, in the form of the life-cycle hypothesis (LCH) pioneered by Modigliani, suggests that the aged will draw down their assets as they age. Cross-sectional evidence (e.g., Wolff, 1990; Hurd, 1990) indicates that assets decline uniformly with age. If the mean wealth of persons aged 65-69 in 1988 is indexed to equal 100, the mean wealth of those 70-74 was only 66, and that of persons 80 or over was 41. Of course, these findings offer no strong evidence for or against the LCH. Different cohort or period effects could account for wide differences in wealth accumulation across these age groups just as well as could the LCH.

Studies based on panel data—mainly those from the Retirement History Survey (RHS) and SIPP—indicate that the elderly do dissave (in real terms), albeit at a slow rate. Hurd (1992) uses SIPP and finds that the single aged dissave at an average rate of 3.9 percent per year. Hurd also suggests that singles decumulate faster than do couples, and that the older aged decumulate faster than do younger aged. However, the SIPP data period is very short (only 36 months), and the reasons for asset decumulation are not easily identified. Moreover, because assets decumulate at very low rates, most aged will have net positive balances at death. It could be that the aged plan to leave bequests to their children or make *inter vivos* gifts; this is the topic of the next section of the chapter. A very real possibility is that assets are kept to meet large expected expenses (vacation cruise, new car, new roof for the house) or unexpected consumption demands (large medical bills) (Hurd, 1992). Finally, it could be that the aged transfer assets in large lumps (i.e., voluntarily draw them down) to qualify for Medicaid assistance with nursing home expenses (Moses, 1990; Liu et al., 1990; Spence and Weiner, 1990; Sloan and Shayne, 1992). The exact reasons and means by which the aged draw down assets are still largely a mystery.

Data Quality

The available high-quality data on wealth status, and panel data on change in wealth status, come from three sources: SIPP (1984 and 1988); PSID (1984 and 1989), and the Survey of Consumer Finances (SCF; 1983 and 1989). As argued in Juster et al., (1989) and Juster and Kuester (1991), the quality of wealth data may, and does, vary among surveys in significant ways. Hence, one must be careful to examine the robustness of results across several surveys. Earlier research (Radner, 1983; Wolff, 1985) indicates that the aged are likely to underreport both income from wealth and financial wealth in standard household surveys. However, according to Juster and Kuester (1991), those assets that are typically underreported tend to be found at the very upper tail of the wealth distribution, where a very few households hold large stocks of unreported wealth or where normal sampling methods fail to produce a sufficiently large number of rich aged. The implication of this result is that for purposes of charting the average size and composition of the wealth of the large majority of the aged-those in the bottom 80 percent of the wealth distribution-the most recent household wealth surveys are of sufficient quality. Those interested in the size distribution of wealth per se among the aged (or any other age group) should focus their research on the SCF data where a special "upper tail" of the distribution identified by the Internal Revenue Service has been added to the normal survey.[11]

Joint Distribution of Income and Wealth

Recent panel data-based research (Juster, 1992) has shown that the pattern of rising income inequality found in the 1980s is reinforced by changes in wealth inequality among these same persons. By and large, the 1983-1989 SCF, the 1984-1989 PSID joint income and wealth data, and the 1984-1988 SIPP data (Juster, 1992; Ryscavage, 1992) each yield three major findings for older households:

1. The income distribution among older households is more unequal

[11] Because of the undersampling of this upper tail, the levels of total wealth reported in most household surveys provide biased estimates of the size distribution of net worth.

than among the rest of the population and did not change appreciably over this period.

2. Liquid asset holdings increased in value during the 1980s across the entire size distribution of wealth, but especially at the top of the distribution.
3. Liquid asset holdings among the bottom 30 percent of households (ranked by income or wealth) are not large. For example, in the bottom 30 percent of PSID households (ranked by net worth), they grew from $300 to $500 over the 1984-1989 period.

In fact, Eargle (1992) shows that in the bottom 20 percent of households ranked by income, heads aged 65 or over (75 or over) had a median net worth of $25,220 ($25,291), of which all but $3,536 ($4,474) was represented by home equity. In contrast, the elderly aged 65 and over (75 and over) in the top quintile of the income distribution had a median total net worth of $343,015 ($390,649) and median financial assets of $208,789 ($252,082). Also Wolff (1990) finds that in 1983, only 10-15 percent of the aged poor had significant wealth holdings, and that various methods for amortizing wealth reduce aged poverty rates by 20 percent at most. Wealth holdings also vary dramatically by race, with blacks having only small fractions of the wealth of whites (Blau and Graham, 1990; Eargle, 1992). The basic conclusion drawn from these studies is that low-income aged generally have low wealth, and that financial wealth is very unequally distributed among the aged by income and by race.

International Comparisons

International comparisons of wealth are few and far between (Greenwood and Wolff, 1992; Wolff, 1987; Kessler and Masson, 1988; Smeeding et al., 1993). The most important finding seems to be the gradual but persistent decline in wealth inequality at the very top of the household wealth distribution (the top 1%) during the twentieth century in Sweden, the United States, and the United Kingdom—the only nations for which such data exist. Evidence of wealth holdings by age are even more difficult to come by. According to Greenwood and Wolff (1988), wealth inequality among the elderly in the 1970s and 1980s was higher in the United States than in other countries, and the U.S. aged had a larger share of total household wealth than did the aged in Australia, Canada, or Japan.

Recently Smeeding et al. (1993) addressed these wealth questions by comparing home ownership and liquid wealth holdings to income using the LIS data base (Table 4-4). Home ownership varies systematically across the nations studied. Between 60 and 75 percent of all aged are home owners in the United States, Canada, Australia, and the Netherlands. In

TABLE 4-4 Home Ownership and Median Ratio of Liquid Wealth[a] to Adjusted Median Income for Elderly[b] Households

	Median Ratio of Wealth to Income		Home Ownership	
Country	All Elderly Households	All Poor (50%)[c] Elderly Households	All Elderly Households	All Poor (50%)[c] Elderly Households
United States, 1986				
All elderly households	5.79	0.30	74.5	60.7
Single females	5.19	0.29	61.0	53.5
Couples	7.94	0.51	89.7	83.1
Canada, 1987				
All elderly households	4.43	0.79	61.7	48.5
Single females	4.59	0.27	39.2	53.3
Couples	5.48	1.57	75.5	43.2
Australia, 1985				
All elderly households	4.53	2.22	77.3	68.7
Single females	3.49	3.34	71.8	81.7
Couples	5.59	2.29	87.9	77.6
Germany, 1984				
All elderly households	2.27	0.33	38.7	40.0
Single females	1.45	0.39	26.2	34.5
Couples	2.18	0.21	50.4	62.9
Sweden, 1987				
All elderly households	2.66	NA[d]	26.2	NA[d]
Single females	2.79	NA	12.8	NA
Couples	2.60	NA	46.4	NA

United Kingdom, 1986				
All elderly households	2.64	0.68[e]	48.2	53.0[e]
Single females	1.94	0.11	37.9	44.4
Couples	3.18	0.11	58.5	53.8
The Netherlands, 1987				
All elderly households	0.87	NA[d]	71.8	NA[d]
Single females	0.87	NA	78.9	NA
Couples	0.76	NA	66.3	NA
France, 1984				
All elderly households	3.60	0.37	NA[f]	NA[f]
Single females	3.89	0.36	NA	NA
Couples	3.20	0.14	NA	NA

NOTE: NA indicates data is not available.

[a]Liquid wealth is defined as property income divided by 0.05.
[b]Elderly are defined as those households in which the head is age 65 or above.
[c]Poor (50%) is defined as households with adjusted incomes below 50 percent of adjusted median household income.
[d]Sample less than 25 households.
[e]Based on 28 households.
[f]Home ownership is not available in France.

SOURCE: Smeeding et al. (1993:Tables 7,8).

Germany and the United Kingdom, home ownership is much less prevalent, running at 38 to 48 percent levels. And in Sweden only slightly more than 25 percent of all aged households are home owners.[12] There is a home ownership gap between poor and nonpoor in all nations except the United Kingdom and Germany. The largest gaps are in Canada, Australia, and the United States. Couples are more likely to be home owners than are single women in most cases. The only anomaly seems to be the higher rate of home ownership among poor single aged women as opposed to nonpoor single aged women in all nations but the United States.

The LIS data base does not directly measure liquid wealth, but does include nominal property income (interest, rent, and dividends from investments in stocks, bonds, savings instruments, and rental property). In order to approximate liquid wealth, reported property income for each household was divided by an arbitrary 5 percent rate of return in each country. This wealth measure was then divided by adjusted income to produce a median ratio of wealth to income for all elderly families and for poor elderly units. The results of this exercise are consistent with the findings of Greenwood and Wolff (1988) in that the United States has the highest overall ratio of wealth to income (5.8) among the aged as a group and among the single female and couple subunits. Canada (4.4) and Australia (4.5) come next, followed by the other nations. Among the poor, the U.S. aged are at the other end of the rankings, having the lowest, or nearly the lowest, ratios of median liquid wealth to median income.[13] It appears that the large variance in aged household incomes in the United States relative to the aged in other nations extends to wealth as well.

Summary

Compared to the amount of research devoted to income, the literature on wealth is sparse. We know very little about several key issues (e.g., the relationships and dynamics between asset decumulation among the aged and the many possible reasons for this decumulation). For instance, the relationship among health status, health care expenses, and asset holdings is of particular interest, given the risks to which individuals are exposed under the U.S. health care finance system. However, finding good measures of all

[12] This result may be due in large part to high rates of subsidy to rental housing among the aged and special housing for the frail aged in the United Kingdom, Germany, and Sweden.

[13] Although interest, rent, and dividends tend to be underreported in most surveys, the underreporting tends to be concentrated at the top of the distribution, thus not greatly affecting the median value.

three of these elements of economic status in any single survey is very difficult at this time.[14]

Little is known about housing wealth across the older segment of the life-cycle (i.e., how it changes with health status, age, and the disposition of the net proceeds of the sale). The existing literature (e.g., Sheiner and Weil, 1992; Venti and Wise, 1990) provides conflicting guidance on this issue.

Finally, and perhaps most importantly, the good household wealth data that we do have—and particularly the panel data from the SCF, SIPP, and PSID—are all collected over almost precisely the same time: 1983 (or 1984) to 1988 (or 1989). This period was marked by dramatic changes in the value of wealth—a booming stock market, high real interest rates, and rapidly increasing housing prices. A major question to keep in mind then is the usefulness of wealth estimates for this period in predicting changes in wealth and its disposition for future cohorts. This period effect also demonstrates the way in which a sustained period of growth in income from capital can create large gains in real household net worth.

INTERGENERATIONAL TRANSFERS

We turn now to the impact of private transfers of income and wealth across generations. There is a large literature on the economic impact of individual public (government) programs explicitly designed to transfer resources across generations—for example, Social Security (Feldstein and Samwick, 1992)—or from deficit financing of government spending. Indeed, in the extreme, one could compute the net transfers received (or paid) by each generation as a result of all government programs.[15] Such issues are beyond the scope of this review, however.

Even with the focus on private transfers, there remain numerous dimensions to the analysis of intergenerational transfers. One could focus on the direction of transfers, types of transfers, timing of transfers, motives for transfers, division of transfers among recipients, and impact of transfers on donors, donees, and the economy as a whole. Our discussion of each is necessarily brief.[16] Moreover, reflecting the focus in the literature, our review places more emphasis on understanding the motive for transfers and their aggregate implications. Only recently has attention turned to documenting the diversity of transfer experience among the elderly.

[14] However, the new AHEAD survey is designed to remedy this deficiency.

[15] Auerbach et al. (1991) present initial estimates using such an approach.

[16] See the chapter by Ronald Lee in this volume for a detailed analysis of intergenerational transfers in an equilibrium context.

Transfers across generations are large. Recent estimates place the flow of bequests on the order of $30 billion to $40 billion per year and the flow of "intended" *inter vivos* transfers (income support, life insurance, and trusts) at $56 billion per year (Gale and Scholz, forthcoming). Including transfers for college education raises the latter figure to $88.1 billion.[17] Moreover, some of the older literature (e.g., Moon, 1977) finds that financial transfers to the aged were almost as large as transfers from the aged in the late 1960s.

It is important to understand the implications of these transfers for the behavior of both parties to such transactions. Why do such transfers take place, and how are they related to decisions to consume, save, organize portfolios, invest in human capital, purchase durable goods such as housing, supply labor, provide insurance against consumption and health risks, and so forth? From a normative standpoint, one would also like to evaluate the implications of intergenerational transfers for economic efficiency and equity. Since transfers are voluntary (with the exception of unintended bequests at death), it is straightforward to conclude that both givers and recipients are made better off by transfers. But the posttransfer level of well-being may fall short of societal norms, or the transfers may have larger implications for the performance of the economy as a whole, for example, by affecting aggregate capital accumulation.

Intergenerational transfers constitute an important part of aggregate wealth accumulation, thus influencing the overall path of productivity and real wage growth in the economy. In the life-cycle model of saving (see, e.g., Ando and Modigliani, 1963), capital accumulation stems solely from the decision of individuals to consume below their income during their working years, in order to finance consumption during their retirement. Kotlikoff and Summers (1981), however, estimated that life-cycle motives accounted for a minority of aggregate wealth accumulation; at the extreme, as much as 80 percent was due to intergenerational transfers such as bequests. Modigliani (1988), however, reached the symmetric, but opposite, conclusion that the life-cycle model accounts for as much as 80 percent of accumulation. The primary differences arise due to the treatment of durable goods, expenditures for college education, and assumptions regarding the degree to which inheritances are saved. (See Blinder, 1988, and Kessler and Masson, 1989, for a thorough discussion of these issues.)

Taking the midpoint suggests that intergenerational transfers account for roughly one-half of wealth accumulation. Other estimates are in the same general range. For example, Hurd and Mundaca (1987) use the 1964 Survey of the Economic Behavior of the Affluent (see Barlow et al., 1966)

[17] Gale and Scholz (in press:Table 6) estimate the flow of bequests in 1983 as $47 billion.

and estimate that 15-20 percent of wealth stems from inheritances, while 510 percent is derived from gifts. In another approach, Greenwood and Wolff (1990) use the Survey of Consumer Finances to calculate changes in age-wealth profile for 1962-1983. They control these profiles with those predicted by a simulation model of wealth accumulation for representative households. In this approach, the difference between observed and simulated wealth accumulation serves as an estimate of transfers. They find that for ages 20-39, such transfers are roughly 85 percent of wealth, and for ages 40-49 they exceed 50 percent of wealth. In contrast, for ages 50-64, transfers were negative, and amounted to 20 percent of wealth. For the elderly, this fraction rises to more than 50 percent for those over 75. Finally, they estimate that an upper bound of 32 percent of wealth comes from inheritances. [18] As noted earlier, averages may be misleading because there is considerable diversity among the elderly. Also, this approach raises the difficulty that transfers are calculated as a residual and thus carry the brunt of specification errors in modeling household wealth accumulation. Still the results suggest a pattern in which net receipt of *inter vivos* transfers declines over the life-cycle. Also, these results emphasize the empirical significance of transfers at death.

In addition to affecting aggregate performance, it is clear that transfers, on average, increase economic inequality. If all transfers were eliminated, inequality in lifetime income would reflect only inequality in labor income, which is much lower than inequality in total income (Auerbach et al., 1992, make this point).[19] Their role at the margin, however, may be quite different. If families act to pool risks, and transfers serve to offset shocks to the incomes of family members, transfers may reduce income inequality. In the other direction, if private transfers are responsive to transfers in public programs, it raises the possibility that private transfers may "undo" the desired distributional effects of public sector programs.

Models of Transfers

Initial work on transfer motives focused on the altruism model of Becker and Barro (see Becker, 1974, 1981; Barro, 1974) in which individuals care about the welfare of family members. Transfers take place to equalize utility among family members. At the limit, if preferences are identical and there is no income lost as a result of transfers, transfers will flow from

[18] See also the extension in Greenwood and Wolff (1992), in which the authors attempt to quantify the importance of three types of effects for wealth accumulation and transfers: life-cycle or age effects, cohort effects, and period effects.

[19] This assumes that all individuals earn the same rate of return on saving out of labor income and human capital investments.

high- to low-income members, and posttransfer income will be equalized. A closely related notion is the tied-transfer model of Pollak (1988), in which parents also care about the utility of their offspring. In contrast to the pure altruism model, however, parents have preferences about the use of the transfer (i.e., they do not respect the preferences of the recipient). This leads to attempts to tie the use of the transfer to specific purposes. A second related model is the impure altruism model of Andreoni (1989), in which parents value the "warm glow" of giving itself in addition to the welfare of the child.

The second major group of explanations focuses on exchange-based motives for transfers. In this view, transfers serve as "payment" for services such as visits and telephone calls (Bernheim et al., 1985; Cox, 1987) or for the purchase of insurance against consumption shortfalls (Kotlikoff and Spivak, 1981). Finally, transfers may also serve to overcome market imperfections, such as in the provision of credit (Cox, 1990).

Distinguishing among alternative models of transfer behavior has important implications. In the pure altruism model, for example, the consumption decisions of a dynastic family are linked. Private transfers will counterbalance attempts to redistribute income among family members, or across generations. In these circumstances, for example, tax and debt finance of government spending will be equivalent (Ricardian equivalence), and the level of private saving and, thus, the resources of the elderly will reflect the desire to transfer resources to future generations. To take another example, in an altruistic framework, bequests will rise to offset taxes on estates, *ceteris paribus,* leaving the posttax estate at the desired level. In such circumstances, an ostensibly redistributive estate tax may even exacerbate inequality (Stiglitz, 1978). Indeed, in an extreme example, all public sector activities may be "neutralized" by offsetting private actions if altruistic links are sufficiently strong (Berheim and Bagwell, 1988). Thus, transfers will play a central role in determining intergenerational income and wealth mobility, as well as the cross-sectional distribution of income and wealth. For these reasons, discerning the degree to which "bequest motives" determine wealth accumulation has been of central attention in the literature on intergenerational transfers.

One possibility is that individuals save for life-cycle and precautionary reasons, but die before consuming their entire wealth accumulation (Abel, 1985; Davies, 1981). In such circumstances, bequests may constitute a large fraction of wealth accumulation despite the fact that there are no links (altruistic or otherwise) across generations.

To test this, one may examine the saving motives of individuals. Hurd (1987) examines data from the Longitudinal Retirement History Survey for evidence of a bequest motive. He focuses on differences in the consumption path (saving rate) of elderly individuals with and without obvious heirs.

Since the patterns are similar, he concludes there is no evidence of a bequest motive.

Bernheim (1991) uses the same data to test the strength of bequest motives. He points out that the Hurd test hinges on the assumption that the marginal utility of bequests is zero if there are no children. His test instead examines the demand for life insurance. The basic notion is that life insurance purchases allow individuals to "undo" the annuitization of their resources due to Social Security benefits and transform their resources into a bequeathable form. Annuities such as Social Security increase the consumption floor of the elderly, but at a cost: they may not be transferred to the next generation. Focusing on changes in Social Security arising from legislative shifts, he argues that increased annuitization was at least in part offset by greater life insurance—evidence of an operative bequest motive.

Another test is to examine the allocation of intergenerational transfers. The basic altruism model predict that the bequest should compensate for differences in income among siblings. Menchik (1980) and Wilhelm (1991) examine the division of estates among siblings and find it best described as equal sharing, a violation of the compensatory model.[20]

Auerbach et al. (1992) revisit the annuitization issue. They use the 1962 and 1983 Survey of Consumer Finances to estimate the degree to which the resources of individuals aged 50 and older are held in the form of annuitized wealth (e.g., Social Security, defined benefit pensions). They find that annuitization has shown a marked increase, especially for two groups: those over 75 and elderly women. This is an important finding in itself. Although the location of the best consumption floor remains open to debate, increased annuitization makes the existing resources of the elderly more secure against the risk of a longer than expected retirement period. As a result of this phenomenon, the authors estimate that the flow of bequests in 1983 (which they approximate at $58 billion) is 20 percent smaller than it would have been at the 1962 degree of annuitization. They further point out that these individuals had the opportunity to purchase life insurance, and thus transfer the wealth across generations, but did not. Thus, it suggests that bequest motives may be less important than life-cycle or precautionary saving desires.[21]

[20] But see also Tomes (1981), who argues that bequests do compensate.

[21] Some have argued (see Kessler and Masson, 1989) that a single model may not be appropriate for all households. For example, low-income households seem to accumulate little saving at all. Hubbard et al. (1992), however, use a simulation model to examine the interaction between the social insurance system and household saving. Many social insurance programs have asset tests, which effectively "tax" saving at prohibitive rates. They find that these incentives may explain the low wealth accumulation of low-income individuals, who are more likely to fall into these programs. As a result, the low wealth accumulation of these individuals does not necessarily constitute evidence against the life-cycle model of saving.

More direct evidence on the intentional transfer of resources is offered by Gale and Scholz (in press), who focus on intended *inter vivos* transfers. By focusing on this subset of transfers, they eliminate the ambiguity posed by bequest motives. Using the SCF data, they estimate that intended intergenerational transfers—support, life insurance, and trusts—are at least 20 percent of wealth. Because it ignores a large fraction of intergenerational transfers (college expenditures and bequests), they argue that this estimate constitutes a lower bound for the contribution of operative intergenerational linkages to aggregate capital accumulation.[22]

Gale and Scholz make no attempt to distinguish between intentional transfers for altruistic versus exchange reasons. Using a second data set with detailed information on *inter vivos* transfers, Cox (1987) finds that the data are more consistent with exchange-related motives. Using data drawn from the President's Commission on Pension Policy (PCPP), Cox concludes that contingent upon receiving a transfer (and controlling for other factors), the amount of the transfer rises with the recipient's income. The simple altruism model would predict compensatory transfers (i.e., those that fall with income). In the context of an exchange model, however, higher income proxies for a greater value of time and a higher price of services. Thus, the transfer must rise in order to acquire services. Altonji et al. (1992b) note, however, that this test relies on special assumptions; in the presence of unobserved heterogeneity of preferences and a diminishing marginal utility of wealth, the test is not valid.[23]

Similarly, Cox and Rank (1992) use the National Survey of Families and Households, as described by Sweet et al. (1988), to reexamine the exchange model of transfers. The basic model is the same as Cox (1987), and the basic result is the same: conditional on receiving a transfer, the amount of the transfer rises with recipient income. [24] An unsettling aspect of the study, however, is that the measures of services (contacts and help) are not significantly correlated with transfers, thus calling the exchange motive into question.[25]

[22] The Gale and Scholz study is one of the few to examine differences in transfers along racial lines, finding that there are large differences in average amounts of transfers between blacks and whites, although race per se appears to have little effect on the propensity to transfer. Instead, the other variables (income, etc.) explain this difference.

[23] The data set does not contain information on the income of donor (Cox uses the mean for the donor's census "survey block" as a proxy). Since it is the relative income of the donor and recipient that should determine the probability of making a transfer (see Altonji et al., 1992b), this raises the specter of misestimation in the first stage.

[24] Cox and Rank control for permanent income of the donor through the use of characteristics of donors, an improvement over Cox (1987) that reflects the liquidity constraints found by Cox (1990).

[25] One possibility is that the services could be rendered at a later time. The data requirements to examine both the existence and the timing of exchange are quite severe.

As noted earlier, transfers may also be motivated by the desire to overcome credit market constraints. Cox (1990) uses the PCPP data to find that transfers rise with the ratio of permanent to current income for recipients. He interprets this as evidence that transfers flow to those whose current earnings fall short of their optimal unconstrained consumption path. The qualitative nature of the results is not affected by dropping college students or by eliminating those that share living quarters with the donor. Of course, the difficulty in executing such a test is the need to generate a predicted, or fitted, value of permanent income and the inability to control for the characteristics of the donor.

Finally, transfers may reflect the purchase of insurance against consumption risks. Altonji et al. (1992a) find that the extended family tends to weakly stabilize consumption (i.e., to act as a risk-pooling device). Specifically, individual's consumption is positively related to family income, *ceteris paribus.* They conclude, however, that altruistic links are far from perfect. An alternative approach would be to employ the direct tests for consumption insurance in Cochrane (1991) or Mace (1991) to examine directly the extent to which the consumption of the elderly is de facto ensured against idiosyncratic shocks. Of course, the difficulty with such an approach is the absence of high-quality data on the consumption of the elderly.

Thus far, the discussion has focused on transfers from the elderly to younger generations. Evidence suggests, however, that roughly 20 percent of the elderly receive some sort of financial transfers from adult children (Soldo and Hill, 1991; Stephen et al., 1991). Similarly, there is evidence that younger generations pay (at least in part) the costs of in-home personal care for the elderly (Liu et al., 1990; Wiener and Hanley, 1992), as well as purchase costs of technologies to assist the parent and of improvements to the accessibility of homes.

As with transfers in the other direction, theories of altruism postulate that children make financial transfers to their parents because they care about their well-being. In contrast, exchange theories suggest that the *inter vivos* transfer compensates for a service provided to the child or, perhaps, a larger inheritance.

In this setting, the particular attributes of the exchange may be different. For example, the child of an infirm parent may wish that the parent continue to live in a separate dwelling. Alternatively, the child may wish the parent to avoid depleting the entire estate simply to qualify for Medicaid. In such a setting, the amount of the transfer will rise as the parent becomes closer to needing help in self-care or closer to moving in with the child. In these cases, it becomes more costly for the child to "purchase" his or her independence. If the transfers are tied, the child designates the particular purpose for which the transfer may be used. In an extreme case, the child purchases directly on behalf of the parent.

The empirical evidence concerning the various economic models is quite sparse. Thus far, for example, there is no general evidence concerning the determination of transfers of time or financial support to the elderly. Indeed, one would expect that there would be substitution between the two types of transfers; the greater the value of time for the child, the more likely he or she is to make a transfer in financial terms.

In sum, the research to this point is inconclusive. There appear to be several plausible motives for transfers of wealth across generations, and no single "smoking gun" explanation dominates the others. The hypotheses about the motives for transfers indicate the need for a better understanding not only of contemporaneous flows of time and money, but also of the possibility of trading exchanges across time. Put differently, the timing of transfers may be as important as the existence of the transfer itself.

Economic Impact of Transfers on Households

Intergenerational transfers are of interest in part because of their contribution to intergenerational income mobility. Recent evidence suggests that there are significant links between the economic status of fathers and sons as measured by earnings and incomes. Solon (1992) uses the PSID to test whether there is rapid regression (across generations) toward the mean in incomes. He finds a correlation in economic status (income) of 0.4 between fathers and sons. Similarly, Zimmerman (1992) uses the 1966 cohort of the National Longitudinal Study and estimates that the elasticity of sons' incomes with respect to fathers' incomes is roughly 0.4—the same as Solon. Finally, using a different measure of the link, Wilhelm (1991) finds that elasticity of son's income with respect to father's income is 0.4 using a high-income sample. [26]

These studies estimate reduced-form correlations, with no attempt to identify means by which status is transferred. As noted in Gale and Scholz, however, roughly 13 percent of those age 65 or older make transfers for the purpose of college education. The transfers are large in the aggregate (transfers for college expenses are roughly $32.5 billion, or nearly 60% of all intended transfers) and average more than $9,000 per donor, and the propensity to make such a transfer is greater for high-income individuals than for low-income individuals. Combined with high estimates of the return to

[26] A drawback to these studies is that each relies on data for the same historical period, and each focuses on father-son correlations. Thus, it is difficult to extrapolate these results to the future, and they provide little insight into the mother-son, father-daughter, etc., links that will become more important as children of both sexes raised within both single- and double-earner families enter the labor force.

education (see Ashenfelter, 1991), this evidence suggests that *inter vivos* transfers for college education are central to the effects of transfers on intergenerational economic mobility as a whole. The incentives for private expenditures on college education are interesting for other reasons as well, since they may be offset by changes in public support for higher education. On this issue, however, there is little information.

In an early study, Lampman and Smeeding (1983), using information culled from a variety of sources, found that the ratio of private transfers to public transfers fell over time. They were able only to conjecture, however, regarding the causal links between the two series. More recently, however, Schoeni (1991) used the transfer supplement to the 1988 PSID to provide microeconomic evidence on crowding out of transfers. He finds that 26 percent of those getting Aid to Families with Dependent Children, Unemployment Insurance (UI), or workers' compensation in 1987 also received private transfers, but that the private transfers averaged only 4 percent of income. Focusing only on those receiving UI, he also concludes that government transfers "crowd out" about 30 percent of private transfers.[27]

Virtually every study of intergenerational transfers treats income as exogenous, but there is evidence that transfers may also affect labor supply. Holtz-Eakin et al. (1993) examine income tax data on the labor-force behavior of people before and after they received inheritances, and find that the likelihood that a person decreases his or her participation in the labor force increases with the size of the inheritance received. As noted in the introduction, this suggests a need to reexamine studies of the life-cycle hypothesis that assume a donee's labor supply response to inheritance is perfectly inelastic and casts doubt on the validity of simple altruism models that assume dynastic families freely optimize with respect to a single generationally linked budget constraint.

Wilhelm (1992) analyzes changes in hours worked before and after receipt of an inheritance, using a small subsample of the PSID, and finds no relationship. However, the PSID relies on self-reported values of inheritance; Menchik (1988) has documented that such measures are subject to substantial error.

[27] Schoeni argues that pure altruism predicts a one-for-one crowding out, whereas the tied-transfer model (Pollak, 1988) is ambiguous. Exchange theory, however, is even less clear. Cox and Rank (1992) point out that in an exchange model of transfers, public transfers may not crowd out private transfers (and vice versa). Instead, by raising his or her bargaining position, the public transfer may augment private transfers to the individual. Warm-glow giving offers a strong prediction of no effect.

Summary

From the research surveyed above, the following broad picture emerges. First, there are extensive intergenerational links and these links are inconsistent with simple models of altruism alone. Second, although the bulk of research has focused on aggregate issues, there are important unexplored issues in heterogeneity. Third, *inter vivos* transfers are quantitatively more important than bequests and are more prevalent across all parts of the income distribution. Despite this, the majority of attention has been focused on bequests. Finally, no study has simultaneously considered *inter vivos* transfers and bequests. As a result, our understanding of the forces driving net intergenerational resource flows is necessarily incomplete.

TOMMORROW'S ELDERLY AND RESEARCH ISSUES

Evidence from the 1950 to 1980 censuses (Smolensky et al., 1988) and from wealth surveys taken between 1962 and 1989 (Wolff, 1985; Avery et al., 1984; Juster, 1992; Eargle, 1992) indicates that the current generation of "young" elderly (i.e., those born between 1920 and 1930 who reach age 65 between 1985 and 1995) will be better off as a group than yesterday's elders. This age group (aged 30-42 in 1960) has had the good fortune to be in their prime working years during the period of rapid earnings growth in the halcyon 1960s, to have had the value of their homes soar during the inflation of the 1970s and early 1980s, and to be in the portfolio position to capture the high real interest rates and stock market boom of the 1980s. Indeed, individuals born in the 1920s have been dubbed the "good times" generation (Moon and Smeeding, 1989). The 1983 SCF (Avery et al., 1984) indicates that the mean net worth of those 55-64 in 1983 (who were born between 1919 and 1928) was 84 percent above the national mean net worth. Similar earlier surveys for 1962 and 1969 indicated that the 55-64 year olds in those years (whose survivors are among today's elderly) had net worth holdings that ranged only from 39 to 56 percent above the national average.

The generation that will become aged before the turn of the century and shortly after is also more likely to have a greater fraction of long-term two-earner families, and hence a larger share of persons receiving higher than average amounts of private pensions and larger Social Security benefits than any preceding generation. Grad (1992) indicates that 57 percent of aged couples, 41 percent of unmarried men, and 32 percent of unmarried women received some form of private pension in 1990. Simulations by various consultants as reported in Reno (1992) forecast large increases in these ratios, to 86, 70, and 50 percent, respectively, by 2010.

On the other hand, the least interesting statistic among the aged is the average or the "percentage with" some asset or type of income. For instance, consider occupational pensions. Recent reductions in pension coverage (Bloom and Freeman, 1992; Goodfellow and Schieber, 1992) are not reflected in the projections reported in Reno (1992). Dynamic simulation models are programmed to play out a set of assumptions regarding wage growth, pension coverage, survivors benefits, etc., none of which may in fact turn out to be true and the sensitivity of which—if it is tested—is rarely reported. Moreover, the receipt of an occupational pension says nothing of its value or generosity now—or in the future. What we do know is that private pensions are at best partially indexed and that their distribution is highly skewed. Grad (1992) reports that occupational pensions from private firms or government retirement represented 20 percent or more of aggregate income only for those aged households in the top 40 percent of the income distribution. The bottom two quintiles of the aged ranked by household income received only 3.4 and 7.9 percent of their respective incomes from these sources. Pestieau (1992) finds a similar distribution across older households using the same LIS countries shown in Table 4-4.

And so, we are quite reluctant to speculate about the future status of the aged given the large amount of missing information on such items as private pension receipt, pension adequacy, and the like. [28] Moreover, we realize that forecasts for the "elderly" as a group are rather hollow. At any point in time the "elderly" can be defined to include three or four groups of "retired" people who fall into four age ranges—the 55-64 year olds (near elderly by some accounts), 65-74 year olds (young aged), 75-84 year olds (transition years or "middle-aged" elderly), and those 85 and over (the oldest-old). Each of these generations faced, is facing, and will face, distinctly different prospects as it ages. Further, each group will have had different life-cycle income experiences during key periods of its members' lives. Moreover, *within* each of these cohorts there is a highly skewed distribution of income and wealth. And last, but not least, recent research on cross-national comparisons of the aged indicates that the United States is at one extreme or another—both good (the highest income and wealth, younger aged couples) and bad (poor older women living alone)—in almost any comparison one can make. Recalling Quinn (1987), we are highly uncomfortable about saying much of anything specific about "the aged" of tomorrow. Statements such as "there will be poverty and affluence" or "women will do worse than men" seem rather empty for us. We would rather con

[28] Salisbury (1993) reports that up to $35 billion (out of a total of $125 billion) of yearly lump sum pension payouts for job changers—at least $35 billion and perhaps up to $80 billion a year—are not rolled over but are instead used for paying bills or for unmet consumption needs. The net effect of these decumulations has not been well charted by anyone at this time.

centrate our remaining space on what is needed to make meaningful comparisons, than to paint fuzzy pictures of the retirement years of the baby-boom generation.

Data Gaps

We anticipate that two new surveys, the HRS (health and retirement) and AHEAD (health, assets), will put us in a much stronger position to assess, explain, and forecast the economic status of the aged. Each of these panel data sets combines information on health, wealth, income, and related issues. The design of the health-wealth-income change linkages in these surveys reflects the input of researchers knowledgeable in the issues and data gaps, and what is (was) needed to fill them. Accordingly, many of the questions posed here will be addressed in the near future. Finally, because these are continuing panel data sets, new supplements to each survey will permit researchers to address fairly quickly and thoroughly many of the questions that are just beginning to emerge. Social scientists who work in other areas of the age distribution (e.g., children) will likely wish they were as lucky as are researchers in the area of aging.

Neither survey, however, fills the major gap we find in studies of the aged: consumption. A fundamental flaw in the Bureau of Labor Statistics' annual Consumer Expenditure Survey (CEX) is its failure to balance consumption (C) and income (I) with change in net worth (ΔNW). Because of this incomplete linkage of flows into and out of the consumer unit, reporting errors and behavioral changes in C or I may be confused with ΔNW at several levels. Without ΔNW, we can only speculate on how people pay large medical bills, dissave, borrow, bequeath, and/or otherwise change assets. There are two solutions to this problem: either add direct consumption measures to HRS and AHEAD, or measure C as the residual to I - ΔNW. It seems to us that the latter strategy is the easiest way to go.

On the international data front, progress is being made in two directions. The LIS project is moving both forward (new data sets with more recent data every 4-6 years) and backward (data for 1970-1980), and adding new countries at a rapid pace. Over the next 10 years, it should allow us to expand both our breadth and our depth of knowledge about the aged via cross-sectional and cohort studies. Moreover, a new project sponsored by the National Institute on Aging to make the PSID and GSOEP comparable, is for the first time allowing us to compare directly the impact of life events on changes in living standards among the aged. In the future, we expect that other nations' data sets will join these two to provide the basis for an even more rich tapestry of cross-national research in the economics of aging and retirement.

Knowledge Gaps

While the data gaps are being filled, these new data are of use only to the extent that we can employ them to answer questions that interest us and are today unanswered.

In general, this survey leads us to the following conclusions regarding knowledge gaps:

- *There has been a greater research emphasis on income and income change than on wealth and wealth change (savings and dissavings).* In particular, research on poverty or economic disadvantage has concentrated mainly on income and income change, with little emphasis on wealth and wealth change, or on needs assessment. At age 65, aged in the United States have the highest income and wealth in the world. After age 75, the United States has the highest fraction of low-income aged women living alone in the world. How do we go from one stage to the other? What is the role of health status, health care finance, and other factors in explaining moves from one state to the other? There has been very little research examining how economic needs (e.g., health care) among the aged affect household budgets, consumption needs, and wealth decumulation among the least well-to-do aged.
- *Our understanding of the transfer of economic resources across generations must be strengthened.* In the area of wealth transfer, we have literally touched only the tip of the iceberg. The most obvious step is to extend research into the motives for intergenerational transfers. In part, this exercise will be aided by survey data on the expectations of the aged such as those in the HRS, but additional steps would be useful. There is a clear need for treating transfers in a life-cycle context, although the data requirements are severe. Specifically, how does the expectation of making a transfer affect the consumption, housing, financial, and other decisions of the elderly? How does the expectation of receiving such a transfer affect the human capital accumulation and other decisions of the young? Such research would effectively permit one to understand how transfers affect income, not simply the reverse.

A second area is the interaction between public and private transfers. There are strong reasons to expect that annuitization of the elderly through programs such as Social Security, and the interaction between the social safety net programs and asset accumulation, will affect the size and nature of intergenerational flows. But at the moment, we may at best speculate about these effects. A promising means to pursue these issues may be to exploit international differences in the structure of support programs for the elderly. This requires, however, a commitment to collecting and maintaining comparable data sets across countries.

A third area is simply to extend analyses of transfer motives to a richer set of family circumstances. At present we have little notion concerning how intergenerational links in economic status differ by gender or for children of divorced parents, children of single parents, and so forth. Given the large changes in household structure in the United States over the past two decades, these issues will loom large in the future.

Last, despite the fact that the aggregate net flow of transfers is from the old to the young, significant flows occur in the other direction. What determines the extent and timing of these flows? What is their contribution to the distribution of well-being among the elderly?

- *There have been relatively few cross-national studies.* Important questions such as the amount of precautionary savings in an economy, the poverty risks associated with widowhood and truly old age, and related issues are just now being explored in this context. Internationally comparable data offer researchers an important window for comparisons. Owing to the similarity of life span across the developed nations, and similarities and differences in relative cohort size, cross-national comparative data on wealth and income should be more fully exploited over the next decade.

The policy implications of this research are vital. If we are to provide a more secure, stable, and healthier old age for our citizens, changes in economic status cannot be ignored. If we can answer many of the questions posed here over the next decade or so, we can then turn our efforts and data sets over to the next generation of researchers who can put their minds to worrying about our retirement.

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5

The Elderly and Their Kin: Patterns of Availability and Access

Douglas A. Wolf

INTRODUCTION

In recent years the field of family demography has developed rapidly. These developments include theoretical and methodological advancements and an especially rapid growth of applied research driven by the availability of large, nationally representative household surveys, as well as several longitudinal data sources (for a survey of the field, see Bongaarts et al., 1987). This chapter addresses issues in what might be called the "family demography of the elderly." First, and most fundamental, we consider the composition of families containing elderly. Under the heading "kin availability," we address the observability of kin structures, ranging from the simple—counts of living kin occupying specified relationships—to the complex—enumerations of individual surviving kin according to type of relationship, with each member of the kin group described by an array of attributes. The second major focus is summarized by the term "access" to kin, which here has two manifestations: either the face-to-face access implied by coresidence, or the less intense or sustained access implied by close spatial proximity

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(e.g., that which accompanies residence in the same neighborhood or community).

One of the more remarkable demographic trends of recent decades is a reduction in household size, a trend that has been noted for persons of all ages and in numerous countries. Although a number of underlying factors help explain this trend, one of particular importance with respect to older people is a post-World War II trend toward having fewer children with whom to coreside. As illustrated below, however, this trend has recently reversed (or will soon reverse) in many industrialized countries. Household structure (or "living arrangements") is thus in part a consequence of patterns of kin availability and is the second major topic addressed in this chapter.

The third and final topic addressed is the spatial proximity of elderly and their kin, especially their adult children. Throughout, an effort is made to survey, albeit selectively, theoretical, methodological, and empirical contributions to the relevant literature. Some attention is also devoted to enumerating existing data sources that figure prominently in actual (or potential) research.

KIN AVAILABILITY

Demographers and other social scientists have a long history of interest in kinship. Lotka (1931), in an article on the relationship between mortality and orphanhood, developed methods for determining the probability that a person at a given age has a living parent. More generally, demographers have devoted efforts to describing kinship patterns and to the formulation of models that relate kin patterns to underlying demographic forces. These issues are the concern of the present section.

Kin availability is of particular importance with respect to the elderly, since members of the kin group constitute a resource pool—with "resources" construed broadly to encompass space (i.e., shared residential space), time, and money—on which elders in need of care or assistance can call. The kin group also represents, of course, a set of potential claimants on similar resources held by the elderly. Thus the composition of a kin group defines a complex set of potential interpersonal linkages that are of substantive interest.

Conceptual Issues

Inclusiveness of Measures

Before attempting to measure patterns of kin availability, it is necessary to establish the scope of the term "kin." Our concern is with kin groups containing at least one elderly person. The specific labels attached to linkages between individuals differ according to who in the kin group is taken to be the reference person, or "ego"—for example the relationship between two individuals may be "uncle" or "nephew" depending on who is ego. Furthermore it is clear that in common usage of the term, a person is likely to simultaneously be part of more than one kin group; this is especially true of married people.

The range of relationship ties encompassed in the term "kin group" will differ across studies and across disciplinary lines. It should also be noted that descriptions of kin patterns are rarely of purely intrinsic interest; rather, of interest are the roles occupied, and the functions performed, by individuals in the network, and the dynamics through which these roles and functions develop. As has been demonstrated in numerous sociological and anthropological studies, the nature, composition, and functioning of kin groups differ considerably across cultural, ethnic, and/or racial lines, and the inclusiveness of kin groups can extend well beyond ties defined by blood and marriage (see, for example, the classic study of urban blacks in the United States by Stack, 1974).

Nevertheless, this chapter adopts a narrowly demographic perspective, limiting its attention to relatives defined with respect to blood or marriage. This perspective reflects a desire to relate kin patterns to underlying demographic processes. It also reflects a concern with the ability to generalize from empirical findings, which leads to an emphasis on research based on population data or on data from large-scale surveys. Available data, in turn, tend to provide only a limited range of information on the composition of kin groups. In fact, the following discussion is generally restricted to immediate relatives—parents, siblings, and children—and only occasionally extends to more distant kin found along direct lines of ascent or descent, such as grandparents and grandchildren.

Among the married elderly, the spouse is possibly the most important member of the kin group. Moreover, the death of a spouse is a key life course transition, experienced in most cases late in life, and is often accompanied by major shifts in economic circumstances. Nevertheless, this chapter devotes very little attention to spouses: data availability is considerably more problematic for kin relationships other than spouse; modeling issues are more complex for relationships such as child, parent, and sibling (where the *number,* not just the *existence,* of such kin is itself a variable); and the consequences considered here—coresidence and proximity—are the result of very different underlying processes for spouses and for other members of kin groups.

Even with a narrow demographic conception of kinship, observed shifts or long-term trends in patterns of divorce, remarriage, and childbearing imply that the kin-availability patterns of successive cohorts of elderly will become more and more complex. The "blended family" so prevalent in some contemporary societies, in which one or more spouses/partners are in second (or higher-order) marriages containing children from two or more marriages, is an example of a phenomenon that will increase the prevalence of half- and stepchildren and siblings (among others), in addition to own and in-law children and siblings, in the kin groups of the elderly. These considerations raise issues of measurement and analysis that have scarcely been addressed in the literature on old-age living arrangements and family support behavior.

Demographic Forces Underlying Kin Availability

It is evident that the essential demographic forces that determine the size, age structure, and gender mix of a population—patterns of birth and death, by age—underlie patterns of kin availability as well. To fertility and mortality rates we must add patterns by age of marriage, divorce, and remarriage as well, since marriage creates linkages among the parents, siblings, and offspring of married couples, whereas divorce and later remarriage modify and further widen the network of kin and the interrelationships between individuals in the kin group.

At a specified age, the size and composition of one's kin group provide a partial record of one's demographic history. The survivorship and ages of parent (s), for example, reflect the parents' ages (and, therefore, their *relative* ages) at ego's birth—for *any* selected ego—as well as the specified age of ego and the relevant age- and sex-specific mortality rates. The same is true with respect to ego's spouse. The presence in ego's kin group of living siblings with specified characteristics depends on parental fertility history, ego's position in that history, and the relevant patterns of survivorship, while the number, ages, and gender mix of living children reflect ego's *own* childbearing history as well as survival patterns within the relevant cohorts. Finally, the presence and age/sex attributes of any in-laws, stepsiblings, stepparents, and/or stepchildren, all reflect the history of divorce, remarriage, and childbearing within specific marriages.

Thus, indicators of the size and composition of kinship networks will be influenced by changes in age- and sex-specific mortality, fertility, marriage, divorce, and remarriage rates, as well as by age differences between spouses. It is beyond the scope of this chapter to attempt any characterization of the many and complex trends in any of these underlying demographic processes. Consider, however, an array of indicators of the size and composition of kin networks. For a randomly selected older woman, for example, we might wish to measure whether a spouse is present; the number of surviving sisters (brothers); the number of surviving married (unmarried) daughters (sons); the number of surviving parents; and so on. Analy sis of the effects on each such indicator of changes in any of the underlying demographic forces—an upward or downward shift in fertility rates at all ages, or movement to the right of the age curve of first marriage, or a lowering of sex-specific and age-specific death rates, for example—leads to the following general conclusions. First, each of the underlying demographic forces will have consequences for many, if not all, of the selected indicators. Second, each indicator will tend to be affected by changes in many, if not all, of the underlying demographic forces. Finally, the net effect on any indicator of a change in any one of the underlying demographic factors will depend on levels and trends in all the other factors, as well as any interactions among them. Complexities of these sorts have been addressed by using a variety of demographic models; these models are discussed in more detail below.

Empirical Issues

Aggregate Measures of Kin Availability

Population aging is an aggregate phenomenon, one revealed by a change in the age structure of a population. It is possible to construct simple measures of one aspect of kin availability—the availability of children—in the aggregate, by using population data. An early contribution to the modern literature is an often-cited study by Kobrin (1976), who showed that the path of a simple measure of kin availability—the ratio of "daughters" (women aged 35-44) to their unmarried "mothers" (widowed and divorced women aged 55 and over)—closely paralleled that of average household size in the United States during the period 1890-1973.

Measures based on aggregate data, such as those used by Kobrin, have certain limitations. For example, it is impossible to align population counts exactly by age so that they delineate distinct generations. Furthermore, aggregate measures provide information only about the *average* of kin-availability patterns, omitting important features such as the extent to which the elderly are childless or to which adults are without living parents. Yet aggregate measures have the obvious virtues of demanding only minimal information—population counts by age and sex (and, in the case of Kobrin's series, marital status)—and of showing clearly the relationship between population aging and average kin-availability patterns.

Figure 5-1 illustrates the time path of a variant of Kobrin's index (in particular, its reciprocal) for selected major regions of the world, using regional groupings and data produced by the Population Division of the United Nations.[1] The underlying data reflect actual data (including esti

[1] The data are extracted from the series "Sex and Age 1950-2025" and are described fully in the United Nations (1993).

mates) for most countries through 1985 or 1990, and the United Nations' medium variant projections thereafter. The "mother-daughter ratio" shown is the ratio of women 65 and older to women 25 years younger, a rough approximation of the mean length of a generation.[2]

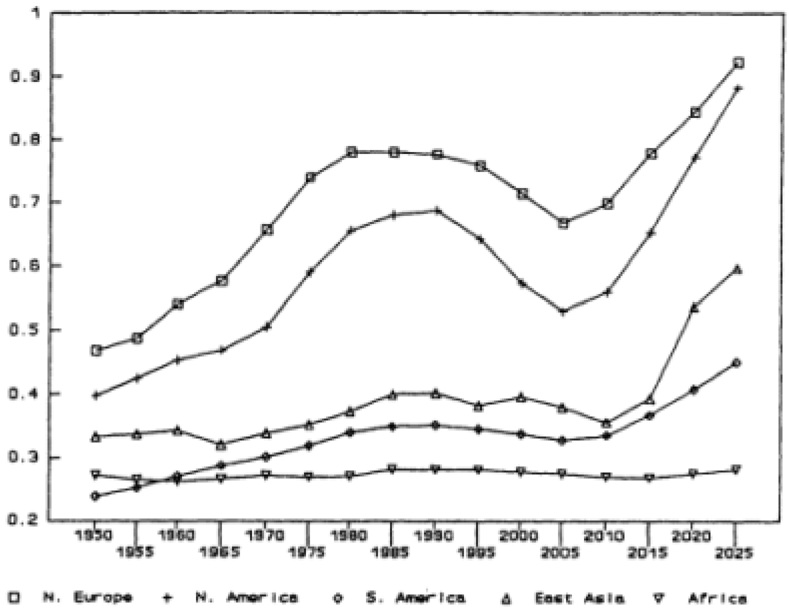

Figure 5-1
"Mother-daughter" ratio for selected regions of the world, 1950-2025.

In both the northern European countries as a whole and North America (Canada and the United States), a distinctive pattern can be seen, in which the mother-daughter ratio has climbed steeply for much of the period 1950-

[2] Specifically, the ratio is calculated as

$$\left(\frac{n_{65-70}}{n_{40-45}} \times \frac{n_{65-70}}{N_{65+}}\right) + \left(\frac{n_{70-75}}{n_{45-50}} \times \frac{n_{70-75}}{N_{65+}}\right) + \left(\frac{n_{75-80}}{n_{50-55}} \times \frac{n_{75-80}}{N_{65+}}\right) + \left(\frac{n_{80+}}{n_{55-60}} \times \frac{n_{80+}}{N_{65+}}\right)$$

where nx is the number of women in the indicated age group, and N_{65+} is the total number of women 65 and older. That is, in each of four "mothers" age groups, the ratio of that group to women in the 5-year age group 25 years younger is calculated; then the weighted sum of these four ratios is obtained, with weights representing the proportions that the mothers' age range represents, relative to all women 65 and older.

1980. During the years 1990 through 2005, the upward trend is expected to reverse, although in neither region is the ratio expected to fall to levels as low as those seen in 1950; after 2005 the trend is projected to reverse once again, with an even sharper increase to unprecedentedly high levels by 2025, when the projected series ends. These curves clearly portray the late-life consequences of being in generations that successively produced baby "booms" and baby "busts."

The northern European and North American patterns just described are not repeated in the other parts of the world shown in Figure 5-1. However, a pronounced rise in the mother-daughter ratio can be anticipated in eastern Asia after 2010, paralleled by a gentler increase in South America. Africa, with an overall pattern of sustained high fertility, exhibits a near-level mother-daughter ratio throughout the period of historical and projected data.

Measures Based on Individual-Level Data

Censuses and sample surveys have for the most part failed to produce information with which to describe kin-availability patterns, since they have usually focused their questions on individual respondents and the households in which they live. In a typical household-based survey, one or more individuals serve as respondents, generally either enumerating the other individuals with whom they live or providing responses that summarize the composition of the household. This generates information about only the *coresident* parts of kin groups.

Less systematic is the availability of information on the full set of living kin for even a limited set of kin types. The existence of a spouse, even if not coresident, can often be inferred from survey items on marital status, although nonmarital unions may be poorly measured. Problems grow as we consider children, the category of most interest for studies of the elderly population. The crudest measure of available children is number of children *ever born.* Several existing data sources include information on the preferred measure, a count of *living* children, while some go further, eliciting information on each living child. Even less common are questions pertaining to siblings, grandchildren, and more distant relatives.

A Sample of Microdata Sources

As part of its monthly Current Population Survey (CPS), in which a large rotating sample of U.S. households is interviewed, the Census Bureau has included questions on kin availability, asked of all adults in sample households, on four occasions: July 1987, June 1988, November 1989, and June 1991. In these surveys, respondents were asked how many living natural parents, brothers, sisters, and children they had. Some descriptive material from the 1988 survey is reported in Woodrow (1990), whereas findings based on the 1989 survey can be found in Woodrow and Peregoy (1991). From a methodological standpoint, these data (and other data generated by comparable survey items) confront the analyst with the phenomenon of "multiplicity sampling." That is, individuals classified according to a particular kin relationship are represented in the sample in proportion to their multiplicity in the population. For example, "sibships" of size four (represented by a respondent who has three siblings) have four times the chances of being sampled as do only-child sibships. Researchers who wish to present results in which the *kin group* is the unit of analysis must adjust sampling weights accordingly (for a fuller discussion of this issue, see Woodrow and Peregoy, 1991). These CPS files, which have the potential to support a range of interesting demographic analyses, have received little attention to date.

Highlights of other major sources of U.S. data on the members of kin groups are presented here in brief. The 1984 Supplement on Aging (SOA) to the National Health Interview Survey contained only limited information on kin: counts of living sons, daughters, brothers, and sisters. A subset of these respondents was reinterviewed in 1986, 1988, and 1990 as part of the Longitudinal Study of Aging (LSOA; see Kovar et al., 1992). The kinship questions were not repeated in 1986, although the number of son/daughter questions was repeated in 1988 and 1990.

Shanas's 1962 and 1975 surveys of the aged in the United States obtained, for each living child, the sex, marital status, birth order, work status, and (if not coresident with respondent) distance (expressed in travel time) from respondent (Shanas et al., 1968; Shanas, 1982).[3] The enumeration of a full roster of living children has also been accomplished in the National Long-Term Care Survey (NLTCS) of 1982, 1984, and 1989. In the NLTCS moreover, additional items were obtained for each child: their age, the presence in their household of minor children, and several indicators of each child's helping activities on behalf of the elderly respondent. A limitation of the NLTCS is its restrictive coverage: only individuals with long-term functional limitations were selected for interviewing.

The 1987-1988 National Survey of Families and Households (NSFH; Sweet et al., 1988) used a large (*N* approximately 13,000) nationally representative household sample, and provided an extensive array of cross-sectional measures of the kin networks of its respondents.[4] For adult children

[3] The questionnaire used by Shanas in 1962 was also administered to samples drawn in Denmark and the United Kingdom; extensive results from the three surveys are reported in Shanas et al. (1968).

[4] A follow-up interview of NSFH respondents was conducted in 1992.

outside the household and for living parents, information on age, sex, marital status, and distance from respondent is available; for parents, the respondent's assessment of parental health is also provided. Only limited information on respondents' siblings, however, was obtained. The spouses of married respondents were asked a parallel set of questions, thus allowing analysis of kin networks containing in-laws and stepchildren. The NSFH has been used in numerous studies on kin relationships involving the elderly, some of which are cited below.

The Panel Study of Income Dynamics (PSID) is an ongoing annual survey of a sample originally containing about 5,000 families in 1968. Individual household members are tracked and interviewed if they depart from a previous sample household, so that over time the sample has grown to include about 7,000 families (Hill, 1992). In 1988, supplementary questions were added to the questionnaire, producing data on the existence and characteristics of nonresident parents and parents-in-law, and on time and money resource flows between the respondent's household and nonresident relatives. Analyses of the resource-flow data have recently begun to appear (Altonji et al., 1992; Furstenberg et al., 1993; Hill et al., 1993).

The Health and Retirement Survey (HRS) is a prospective longitudinal study of a cohort of people approaching retirement age, the first interview of which took place in late 1992 (Juster, 1992). The HRS will provide, albeit for a sample restricted to the age range 51-61 in 1992, the most extensive array of information on kin networks for a large, representative household sample in the United States to date. For all living children, researchers will know age; sex; educational, work, and marital status; own children (i.e., respondent's grandchildren); and (if not coresident) distance from respondent. For all siblings and siblings-in-law, age, sex, and marital status will be recorded; for as many as four each of siblings and siblings-in-law, additional items on work, financial status, and household arrangements will be obtained.[5] Similarly detailed information on each of the respondents' living parents and parents-in-law is also being collected. A parallel longitudinal study of the "oldest-old" is also planned, with many questionnaire items replicated from the HRS and a first wave of interviewing scheduled to occur in late 1993. This Asset and Health Dynamics (AHEAD) survey will, like the HRS, provide unusually detailed information about the kin networks of the elderly.

The preceding survey indicates that existing and anticipated data from surveys of the U.S. elderly offer a variety of detail on respondents' kin networks. While some offer an extraordinary degree of detail, none are

[5] If the respondent has more than four living siblings (siblings-in-law), interviewers select a random subset of four, for which the additional items are recorded.

complete. For example, none of the data sources reviewed provide information on linkages *across* kin groups, e.g. information on the in-laws of the respondents' married children.

In addition to the sources discussed above, there are several other existing public-use data sources containing at least some information with which to study kin patterns. There are also several sources of microdata from other countries, particularly in Europe and Asia. Many of these additional data sources are used in applied studies cited later in this chapter; readers interested in details of the data sources should consult the references cited.

Selected Results from Microdata

Information about kin groups containing elderly can be provided by elderly survey respondents who enumerate their living kin, or it can come from nonelderly survey respondents who report the presence of elderly (e.g., parents) in their kin networks. The way in which the data are collected influences the way in which kin networks can be portrayed. Descriptive data on kin networks, drawn from data sources such as those enumerated above, have appeared in several places. The following discussion concentrates on findings from the most recent sources.

A time series of information on kinship patterns for the United States can be assembled by combining data from several surveys. Crimmins and Ingegneri (1990) combined Shanas's 1962 and 1975 National Survey of the Aged (NSA) data with data from the 1984 SOA. Some of their findings, further augmented by data from the 1987-1988 NSFH, are displayed in Table 5-1. These data indicate that between 1962 and 1975, the proportion of elderly with no living children grew, while the proportion with many living children fell. From 1975 to 1984, the percentage childless fell, while the percentage with large numbers of surviving offspring rose slightly.[6] As noted before, these figures tell a story of the demographic histories of successive cohorts of elderly.

Table 5-1 presents data provided by elderly respondents. Such data can tell us, for example, the distribution by number of children (including zero) of kin groups containing elderly parents. What these data cannot reveal is the extent to which elderly parents appear in the kin groups of the nonelderly.

[6] Comparisons between figures for 1984 and 1987 must be made with great caution because of limits on their comparability. As noted in the table, the 1987 figures pertain only to older women, whereas the earlier figures are for older men and women. Furthermore, the NSFH used a very detailed sequence of questions about children, obtaining separate counts of biological, step- and adopted children; this questionnaire detail may have produced higher (and, presumably, more accurate) levels of reported counts of children than did previously administered surveys.

TABLE 5-1 Percent Distribution of Population by Number of Surviving Children, Persons 65 and Older, United States (in percent)

Number of Children	1962	1975	1984	1987[a]
0	18	21	14	21
1	15	20	18	16
2	17	21	25	22
3-5	27	28	31	}41
6+	14	10	9	
Total	100	100	100	100

[a] Women 65 and older only.

SOURCE: Derived from data presented in Crimmins and Ingegneri (1990) and Wolf et al. (1991b).

Table 5-2 considers the issue of kin groups containing elderly parents and their children, but uses data provided by adult respondents in the NSFH, of all ages. Table 5-2 should be read by column; in each column we find first the percentage of an age group with a living mother aged 65-84, classified by number of siblings, then the corresponding percentages with a mother 85 or older, followed by those whose mother is either under 65 or dead. The latter group constitutes a majority of all three age groups shown in the table. Of the three age groups shown, people 40-64 years old have the highest percentage with a living elderly mother, 44.6 percent. It is interesting to note that among those in this age group with a living mother, a substantial proportion has no siblings (11.7 percent). Children without siblings are likely to bear a larger burden of parental-care than those with siblings.

Note that whereas Table 5-1 tells us that 16 percent of women 65 and older have exactly one living child, Table 5-2 tells us that only about 4 percent of the population simultaneously has no living sibling and a living mother 65 or older. That is, the sibships of size one that are attached to 16 percent of older women represent only about 4 percent of all extant only-child sibships. These distinctions, which illustrate the importance of the "perspective" from which kin relationships are examined (Freedman et al., 1991), must be borne in mind when considering the distribution of familial links within the population, and must be made clear when presenting data on the size and composition of kin groups.

As mentioned earlier, changes in cohabitation, divorce, remarriage, and childbearing lead to changes in the nature of kin networks, lending prominence to distinctions involving half- and stepsiblings/children/parents. Over time, we can expect kin networks to become more extensive, more diffuse, and characterized by possibly weaker ties to a broader array of people. The behavioral consequences of such patterns, with respect to coresidence, other resource flows, and other types of interactions, represent an issue largely unexplored so far, due in part to data shortcomings. There is a need to develop new survey instruments that are sensitive to a broad set of kin and kin like distinctions, as well as a need for research that will uncover the substantive importance of such distinctions with respect to their behavioral consequences. An additional challenge, already present given available data, but likely to grow in salience with better data on more complex kinship networks, is to develop new ways to summarize and display information about the composition of kin groups.

TABLE 5-2 Distribution (in percent) of Adult Population by Age, Existence and Age of Mother, and Number of Siblings, United States, 1987

	Age Group			
Age of Mother	19-39	40-64	65+	Total
65-84				
0 siblings	2.7	10.5	0.1	5.0
1 sibling	1.9	7.1	0.3	3.5
2 siblings	2.5	7.5	0.1	3.9
3 siblings	1.5	4.8	0.1	2.4
4+ siblings	3.4	10.0	0.2	5.3
85+				
0 siblings	0.0	1.2	1.4	0.7
1 sibling	0.0	0.9	0.6	0.4
2 siblings	0.0	0.8	0.6	0.4
3 siblings	0.0	0.4	0.3	0.2
4+ siblings	0.0	1.3	1.3	0.7
Other (mother under 65, or dead)	87.9	55.4	95.0	77.7
Total	100.0	100.0	100.0	100.0

SOURCE: Wolf et al. (1991b).

Models for Analyzing Kin Distributions

In view of the deficiencies of available data on kinship patterns and the need to project future kin patterns, the development of models of kin networks has been an area of considerable activity among demographers in recent years. The modeling efforts can be grouped under three headings: analytic models, macrosimulation models, and microsimulation models.

Analytic Models

Analytic models employ functional transformations of demographic parameters (e.g., age schedules of fertility and mortality) to derive quantities of interest such as indicators of the presence or number of kin. Brass (1983), for example, relates mean household size to patterns of mortality, fertility, divorces, and ages of household formulation and dissolution. Other models have addressed a broader range of kinship indicators, the best-known approach being that of Goodman et al. ("GKP"; 1974, 1975). GKP derive expressions for the expected number of female kin for several ascending and descending generations and degrees of removal from ego, by age of ego, and do so using a minimum of inputs, namely, age schedules of fertility and female mortality. A limitation of this model is that the kin are not themselves classified by age, nor does the model produce the frequency distribution underlying the expectations. Moreover, since information on the variance of number of children is not used in the model, the frequency distribution of number of siblings (and other lateral kin) is distorted (Keyfitz, 1985). Goldman (1986) has used the GKP equations to investigate the consequences for kin counts of recent mortality declines in Korea.

Another class of analytic kin models is based on branching processes (Pullum, 1982). These models can be used to produce full frequency distributions of kin numbers, but generally dispense with the age dimension altogether, which limits their usefulness.

Macrosimulation Models

Macrosimulation is not, strictly speaking, a type of model but rather a way of performing calculations in order to derive results from models too complex to manipulate analytically (Keilman and Keyfitz, 1988). The distinctive features of this approach—of which the ordinary life table is a simple example—are (1) the representation of a population at the group rather than the individual level, (2) a deterministic application of probabilities or rates of transition between groups, and (3) an assumption that individuals are homogeneous within groups. Numerous studies have used the "multistate" life-table methodology to produce marital status life tables, which can be used to study variations in marital status distributions (i.e., the presence of a spouse) among the older population (for examples of this approach, see Bongaarts, 1989; Espenshade, 1983, 1987; Schoen and Nelson, 1974). Bongaarts (1987) has further developed the multistate life-table approach, introducing additional complexity by explicitly representing parity, the number, age, and sex of surviving children, and the coresidence status of children. Bongaarts's model thus represents a substantial step toward a full representation of the nuclear family kin group. Applications of this approach can be found in Watkins et al. (1987), Wijewickrema (1987), and Yi (1986). Lee and Palloni (1992) use the family status life-table approach to investigate the relative contributions of changing patterns of fertility, mortality, age at marriage, and age differences between spouses to the prevalence of widowhood, average number of surviving children, and proportion of widows without surviving sons, for Korean women born in a broad range of cohorts (1890-1894 through 1970-1974).

Microsimulation Models

Analyses employing microsimulation techniques, by contrast to macrosimulation, represent individual members of a population while modeling population change as a result of individual-level stochastic processes. The basic approach used in microsimulation models is as follows: individuals from a real, or hypothetical, population are represented in a microdata file, and relevant events in the lives of individuals—their own birth, the birth of their children, and in some models, marital status changes—are determined to occur by use of Monte Carlo techniques. The input parameters used in these stochastic assignments include birth rates, death rates, marriage rates, age differences between spouses at marriage, divorce rates, and so on. By keeping track of the linkages between individuals in the micropopulation, it is possible to depict the kin network of sample members at any point in simulated time. Since a uniform list of descriptors can be attached to every such individual, kin networks can be described in considerable detail.

Kin models based on microsimulation have been used in a wide assortment of applications. For example, Howell and Lehotay (1978) used their AMBUSH model to analyze the effects of changes in demographic processes on kinship patterns of hunting and gathering societies. The SOCSIM model developed by Hammel, Wachter, and others (Hammel et al., 1976) has been used to investigate historical living arrangements found in preindustrial England (Wachter et al., 1978), to project kin patterns of U.S. elderly in the year 2000 (Hammel et al., 1981), and to study the consequences of fertility change for old-age support in China (Hammel et al., 1991; Lin, 1993), among other applications. Wolf's KINSIM model, which simulates a sample of "family trees," has been used in several studies of family support for the elderly (Wolf, 1988, 1990b; Tu et al., 1993). Other efforts of this type include the work of Ruggles (1987), whose MOMSIM model has been used in historical studies of household composition in the United States, and Smith (1987). For a survey of these and related efforts, see De Vos and Palloni (1989).

Table 5-3 provides some information that hints at the value of microsimulation in studies of the elderly. The upper panel, from Wolf (1988), is a tabulation

TABLE 5-3 Cross-Tabulation of Older Women and Working-Age People in Simulated Populations

	Population Group					
	Working Age People Age 20-64		Elderly with Living Mothers, Age 65+		Older Women	
Country	Number	Proportion of Total	Number	Proportion of 20-64 Group	Number	Proportion of Total
Netherlands, 1970-1980						
No living mother 65+	21,442	0.698				
Mother 65+;						
Sibship = 5+	1,107	0.036	13	0.012	300	0.075
Sibship = 4	2,206	0.072	36	0.016	570	0.143
Sibship = 3	3,032	0.099	58	0.019	1,042	0.262
Sibship = 2	2,173	0.071	53	0.024	1,113	0.280
Sibship = 1	737	0.024	20	0.027	775	0.195
No living children					176	0.044
Total	30,699	1.000	180		3,976	1.000
Taiwan, 1985						
No living elderly mother	15,483	0.696				
With living elderly mother	6,763	0.304	247			
Sibship = 5+	550	0.025	9	0.016	104	0.025
Sibship = 4	845	0.038	31	0.037	219	0.053
Sibship = 3	2,168	0.097	82	0.038	750	0.182
Sibship = 2	2,633	0.118	93	0.035	1,363	0.330
Sibship = 1	567	0.025	32	0.056	599	0.145
No living children					1,096	0.265
Total	22,246	1.000	247	0.011	4,131	1.000

SOURCES: Wolf (1988); Tu et al. (1993).

of individuals in a simulated population corresponding to the hypothetical stable population implied by birth and death rates observed in the Netherlands around 1970-1980. The simulation that produced these numbers employed the assumption that a single set of fertility rates pertains to women of all parities and thus, like the GKP model, may distort the frequency distribution of siblings. The lower panel, from Tu et al. (1993), depicts the hypothetical population implied by mortality and parity-specific fertility rates observed in Taiwan in 1985. In each part of the table three groups are represented. Those aged 20-64 ("working-age people") are tabulated according to whether they have a living older mother and the size of their sibship. Elderly with living mothers (in both examples, a small group) are also tabulated according to the size of their sibship. Finally, women 65 and older are tabulated according to the number of their living children.

Table 5-3 depicts two very different demographic regimes: in the Taiwanese example, more than a fourth of older women have no living children, whereas in the Dutch example less than 5 percent of older women are in this situation. In comparing the under-65 population that does have a living elderly mother, in the Dutch case the modal situation is to be part of a sibship of three (i.e., to share the potential burden of parent care with two siblings), whereas in the Taiwanese example the modal case is to have just one sibling with whom to share the potential tasks of parent care. These differences may be due, in part, to the fact that more realistic assumptions regarding fertility can be maintained by using the Taiwanese data.

It must be admitted that the data shown in Table 5-3 depict kin networks in simulated populations with about the same degree of detail found in Tables 5-1 and5-2, which use survey data sampled from real populations. On the other hand, the NSFH data used earlier (and other data of similar completeness) are rare. Microsimulation offers an opportunity to fill in gaps in existing data—including, as an important special case, data for historical populations that have vanished far in the past (e.g., Ruggles, 1987, or Wachter et al., 1978)—although at the cost of accepting a considerable degree of abstraction in the model and of dealing with pervasive shortcomings of information about the parameters used as model inputs.

Issues in Modeling Kin Distributions

An assumption made in most models of kinship is that the various demographic events underlying kin patterns are independent. In other words, the models assume that the fertility of mothers and daughters is uncorrelated, that mortality is independent within and across generations, that divorce "proneness" is not correlated within or across generations, that mating is random with respect to kin patterns across potential mates, and so on. In the remainder of this section we focus on the issue of independence, or lack thereof, of some of these demographic outcomes.

If demographic events are correlated along family lines, we would expect to see correlations of various counts of kin by type: for example, if women whose mothers had many children also have many children of their own, then there should be a positive correlation between numbers of siblings and numbers of aunts and uncles, and between numbers of siblings and numbers of children. Similar associations could be anticipated if longevity were passed from generation to generation. The converse, however, is not necessarily true: Pullum and Wolf (1991) demonstrate that there are "built-in" correlations among certain kin counts, such as number of children and number of grandchildren, even when all demographic events are independent. For example, Pullum and Wolf show that in a stationary population with independent fertility, the correlation between number of daughters and number of granddaughters is .71. Yet in such a population, the correlation between counts of kin in different lineages (e.g., sisters and daughters, or aunts and granddaughters) must be zero.

There exists ample evidence of correlations between kin counts that are higher than would be expected if fertility were independent within and across generations. Some of this evidence is presented in Table 5-4, which shows correlations between counts of living kin of selected types for women surveyed in the 1984 Hungarian microcensus, for U.S. women in 1984, and for Canadian women in 1985. In the Hungarian data, the correlations between counts of children and grandchildren are, in almost all age groups, well above the .71 that would be expected if fertility across generations were independent. In both the U.S. and the Canadian data, correlations between counts of siblings and offspring are distinctly nonzero; they are also, for unknown reasons, much higher in Canada than in the United States. Further evidence of this sort is presented in Table 5-5, which again uses the NSFH data, to illustrate the magnitude of correlations between selected indicators of kin network composition. As in Table 5-4, the correlations shown pertain to living kin and therefore reflect the combined effects of fertility and mortality. There is a fairly consistent pattern of significant positive correlation between numbers of siblings and numbers of children.

Correlated Fertility Across Generations Particularly for the younger age groups—19-59—the most likely explanation for the correlations shown in Table 5-5 is that there does exist a positive correlation between the fertility of mothers and that of their daughters. A number of papers provide evidence of such a correlation, including Anderton et al. (1987), Hodge and Ogawa (1986), and Danziger and Newman (1989). One unexpected aspect of Table 5-5 is the negative correlation between the number of living parents (which can only equal 0, 1, or 2) and the number of children, for those

TABLE 5-4 Selected Empirical Correlations Between Counts of Living Kin, Various Countries Results from Hungarian Microcensus of 1984: Older Women; Children and Grandchildren

Age Group	Mean Number of Children	Mean Number Grandchildren	Correlation Coefficient	*N*
55-59	1.9307	2.5572	.7431	7,444
60-64	1.9870	2.9568	.8070	7,239
65-69	1.9442	3.0685	.8255	3,725
70-74	1.9007	3.0863	.8337	5,259
75-79	1.8434	3.0874	.8349	3,467
80-84	1.8339	3.2100	.8039	1,957
85-89	1.6773	2.9902	.7859	815
90+	1.6449	3.2757	.7043	214

Results from U.S. Supplement on Aging File of 1984: Older Women; Sisters and Daughters

Age Group	Mean Number of Sisters	Mean Number of Daughters	Correlation Coefficient	*N*
55-59	1.7015	1.5103	.0916	1,262
60-64	1.6394	1.3991	.0246	1,207
65-69	1.5717	1.2398	.0686	2,139
70-74	1.4638	1.1811	.0738	1,805
75-79	1.2357	1.1485	.0825	1,396
80-84	1.0265	1.0609	.0710	839
85-89	0.8375	1.1615	.0886	420
90+	0.5460	1.3664	-.1346	150

Results from the 1985 Canadian General Social Survey: Older Women; Siblings and Children

Age Group	Mean Number of Siblings	Mean Number of Children	Correlation Coefficient	*N*
55-59	4.1469	3.2030	.3138	315
60-64	3.6726	3.2887	.3266	311
65-69	3.5634	3.2593	.2407	401
70-74	3.4654	2.8560	.1874	507
75-79	3.3790	2.3742	-.0578	434
80-84	2.6147	2.6742	.0943	362
85+	1.8872	2.5524	.1663	357

SOURCE: Data from Pullum and Wolf (1991).

TABLE 5-5 Average Numbers of Living Kin and Correlations Between Kin Numbers, by Age, United States, 1987

		Average Number of Living Kin			Correlation Coefficients		
Age Group	N	Parents	Siblings	Children	Parent, Sibling	Parent, Child	Sibling, Child
19-29	1,795	1.79	2.86	0.87	-.07[a]	-.07[a]	.18[a]
30-39	1,889	1.56	3.00	2.08	-.07[a]	-.08[a]	.16[a]
40-49	1,025	1.14	2.58	3.11	-.08[a]	-.09[a]	.07[b]
50-59	759	0.57	2.49	3.69	-.05	-.00	.14[a]
60-69	738	0.21	1.94	3.05	.04	.02	.01
70-84	705	0.02	1.96	2.20	-.02	.03	.12[a]
85+	86	0.00	1.07	1.78	.00	.00	-.01

[a] $p < .01$.
[b] $.01 < p < .05$.
SOURCE: Wolf et al. (1991b).

under age 50. A young person with fewer than two living parents is likely to have had a parent who died relatively young. It may be that people who experience parental death while young tend to marry early, hastening their exposure to the risk of childbearing.

Familial Patterns of Longevity Negative correlations between numbers of parents and siblings, such as those shown in Table 5-5, may reflect intergenerational transmission of longevity. There is more direct evidence of such intergenerational correlations of mortality in other research. A number of empirical papers have addressed the "heritability of longevity" (e.g., Abbott et al., 1978). From these studies it has been concluded that any index of such heritability must be very small, although positive. Recent models of mortality incorporating unobserved "frailty" parameters fixed over the lifetime suggest that the upper bound on correlations between observed ages at death must necessarily be quite small, even with perfect inheritance of frailty (Vaupel, 1988).

Some research on familial correlations of age at death has attempted to identify the genetic component of survival by limiting environmental variation and/or by controlling genetic variation. For example, using a sample from an isolated Quebec population, Phillipe (1978) examined the correlations between age at death of parents and offspring, comparing them to correlations between spouses' ages at death. Finding a small difference between the two sets of correlations, the author concluded that the genetic portion of survival is probably near zero, and that correlations between ages of death of parents and children could be due to environmental factors. A recent study of Danish twins (Hougaard et al., 1992) finds evidence for dependence across twin pairs in survivorship, but concludes that the magnitude of the dependence is extremely small.

The sensitivity of measures of the composition of kin networks to variations in the degree of intrafamilial interdependence of fertility, mortality, or any other possible demographic events, has not been suitably explored in models of kin, through either analytic or simulation techniques. This remains as an area for considerable further research.

LIVING ARRANGEMENTS

A major thrust of recent research in the demography of aging has been to document and explain dramatic trends in the size and composition of households containing elderly people. The following sections survey major theoretical and methodological topics, and highlight the large empirical literature on this question. As pointed out by De Vos and Holden (1988), there are several alternative indicators of living arrangements that could be used in applied research. In the present discussion we limit our attention to measures of the sort labeled "family household type" by De Vos and Holden. These measures can vary in complexity, but tend to highlight differences among elderly living "alone" (including, among married elders, those living with spouse only), those living "with child(ren)," and "others"—a residual category that, in some instances, can be further subdivided. Thus the categories of the outcome of interest are defined so as to reflect kin availability. Furthermore, by taking this approach, we ignore related dimensions such as type of dwelling unit (e.g., private dwelling, congregate housing for the elderly, institutions) and household headship.

Conceptual and Theoretical Issues

Most recent research on living arrangements of the elderly is consistent with a conceptual framework of rational choice, in which the living arrangement actually observed is assumed to be chosen from a set of discrete alternatives and is assumed to be the one alternative valued most highly by the relevant decision makers. This framework has been developed by several writers, including Beresford and Rivlin (1966), Michael et al. (1980), and Schwartz et al. (1984).

In the abstract, we may suppose that at any point in time a given elderly person (or couple) is faced with an array of specific kin, each of whom represents a distinct opportunity for shared living arrangements. The full array of potential living arrangements includes, in addition, unrelated persons with whom the elder might coreside and a "null" option associated with living alone. For simplicity, we can suppose that each child, and possibly each sibling, in the elderly person's kin group constitutes a separate element in this set of opportunities. Attached to any child or sibling, there may of course be additional people such as that child's spouse, own children, and so on.

Suppose, for the moment, that only children and the null option appear in the opportunity set, and that the relevant characteristics of children are captured in the array S^k, for $k = 1, \ldots, K$ (K being the number of children). In addition, the elderly person/couple is described by the array X. The choice framework asserts that decision makers are able to attach a value to each option, representing the level of well-being they attach to the option. There are two important aspects to this evaluation. First, we can suppose that each potential household in the choice set will produce optimal quantities of each of several household goods, with the array of outputs depending on time inputs of each household member and goods inputs. This "productivity" aspect of the determinants of living arrangement choices depends on the technology of household production, summarized in a household production function. The second important aspect concerns the distribution among household members of the output of household production (i.e., the share of each household good produced that is actually consumed by each household member). Some household goods are like pure public goods (i.e., one person's consumption of such goods does not reduce the consumption of others). Other (perhaps most) household goods are, however, partly or fully private in nature; that is, one person's consumption of the good diminishes or rules out another's consumption of that good. Here, we subsume both the productive and the distributive functions in a combined value function that assigns a value to the live-alone option, $V_0 = f_0(X)$, as well as to each coresident-child option, $V_k = f_k(X; S_k)$. In each case, the results represent the value of the indicated living arrangement as determined by the elderly person. In the case of the kth child, there is an analogous function that returns the value to that child of the particular living arrangement (i.e., of coresidence with the elderly parent). The manner in which a division of well-being between parent and child in a coresident household is determined is not addressed here. However, there is no reason in principle why a competitive, bargaining framework, of the sort applied to household decisions by Manser and Brown (1980) or McElroy and Horney (1981), cannot be used here as well. Thus, variations in children's willingness to "supply" (and to demand) coresidence are fully incorporated into the framework and can be viewed as operating through household production and/or the division of household output.

The question of what it is about different living situations that causes them to be valued more or less highly has been addressed by several authors, most comprehensively by Burch and Matthews (1987). Burch and Matthews note that each potential household living situation available to an individual conveys a distinct array of "component" household goods, including physical shelter; storage of property; domestic services (meals, laundry, cleaning); personal care (including, of special relevance to the elderly, assistance with everyday tasks including hygiene, locomotion, and so on); companionship (both social and sexual); recreation and entertainment; privacy; independence/autonomy; power/authority; and the benefits of economies of scale in consumption of any household goods (Burch and Matthews, 1987:499). The benefits of economies of scale can take the form of a larger share of personal money income left for discretionary uses, after paying for market inputs to the production of household goods.

It is clear that the size and characteristics of one's kin network represent constraints on the set of living arrangement choices facing an elderly person. If attributes of children systematically differ with respect to their productivity in household goods and/or the distribution of these goods across individuals in the household, then having more children makes it more likely that the option set contains a highly valued option. However, if there is substantial variation in household output according to the traits of individual household members, then it may be that the composition of the kin network matters more than its size, as a determinant of parent-child coresidence. Monetary resources are an additional constraint on the choice of living arrangements.

Health and disability status can be thought of as a further type of constraint. However, it is perhaps more straightforward to think of health/disability status as factors that operate through the technology of household production, represented here in implicit form by the value functions f_0; ..., f_K. Thus, an unmarried older woman who develops a severe functional limitation is expected to reduce her relative valuation of the living-alone option, since in this living arrangement, basic needs can be met only poorly or not at all, whereas coresidence with a child willing to provide a substantial amount of assistance with personal care will become more highly valued relative to living alone.

The preceding discussion is highly simplified but contains the elements from which a more comprehensive model could be developed. Siblings and other relatives can be added to the set of living arrangement choices. It is impossible to enumerate (or, at least, to represent in an empirical analysis) the set of nonrelatives (friends, paid companions or helpers, paying roomers, etc.) with whom an elderly person might potentially coreside. The residual "other" category of living arrangements can, nonetheless, appear in an empirical analysis; one approach is to assume that the elderly person considers only a restricted set of feasible and/or acceptable alternatives, and that the value function by which the "best" of such alternatives is ranked is adequately represented as a function solely of the older person's traits, $V_r = f_r(X)$.

Empirical Research on the Living Arrangements of the Elderly

Data and Their Methodological Implications

The previous section suggests a framework for empirical analysis in which some measure of living arrangements is related to the full array of attributes of available kin and to other factors thought to influence choices of living situations, through their effects on the production and distribution of household goods. A great deal of the existing literature is, however, based on a much narrower representation of the conceptually relevant factors.

Aggregate Data As discussed earlier, microdata containing information on the availability of kin are not widely available. One solution to the problem of data availability is to construct indices of both living arrangements and kin availability by using aggregate data, and several papers have taken this approach.

Michael et al. (1980) use U.S. state-level data for 1970, regressing a measure of the proportion of widows 65 and older who live alone on variables representing economic and demographic factors, including as a measure of kin availability a "mother-daughter" ratio constructed as the number of women 65 and older relative to the number of women aged 35-44. The estimated regression coefficient for "mothers per daughter" in this analysis is 0.07 (t = 1.92).[7]

Wolf (1989a), using very different data (country-level data for 16 countries, taken at a variety of years during the 1960s to 1980s) obtains exactly the same regression coefficient for mother-daughter ratio as Michael et al. (1980), 0.07 (t = 0.77), but in this case the regression coefficient cannot be judged to be significantly different from zero.[8]

A recent paper by Macunovich et al. (1992) further extends the aggregate data approach, using U.S. data for the period 1965-1990 for five age groups, 65-69 through 80-84, and 85 and older. Measures of the average number of living never-married and unmarried children for these age group/year combinations were developed by using estimates of cumulative fertility and projected survivorship within the respective cohorts. In a regression in which the dependent variable is the logistic transformation of the percentage of widows living alone, the regression coefficient on the variable "never-married children" is -3.441 (t = -5.04). Note that this variable (implicitly, never-married children per older widow) is the reciprocal of a variable such as the mother-daughter ratio used in the aforementioned studies; therefore, all three studies cited obtain consistent results, albeit without uniformly obtaining findings that would be judged statistically significant.

An intermediate use of data is found in Pampel (1992), who employed individual-level survey data as the unit of analysis but an aggregate measure of kin availability (a parent-child ratio analogous to the sex-specific measures discussed above) as a covariate. Pampel is able to use such a measure by exploiting variability across countries (10 western European countries) and time (twice yearly surveys over a 15-year period). Some of Pampel's findings indicate that as the ratio of older to younger people grows, the odds of living alone are significantly increased; however, this result is not robust to alternative specifications.

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[7] The other variables in the model are (1) Social Security Income (SSI), measuring average Social Security payments to survivors; (2) mobility, a measure of the residential stability of a state's population; (3) the percentage of women 65-69 who have a college education; and (4) the percentage of a state's population that is black.

[8] The additional variables used in the regression reported are (1) the ratio of elderly females to elderly males, (2) per capita income, and (3) per capita housing stock—the latter two variables referring to the entire population of the country.

Microdata: Issues of Model Specification and Estimation As discussed previously, available data sources present a range of detail for the measurement of kin availability. At the minimum level of acceptable detail are those sources that record whether an elderly person/couple has living children or, more satisfactorily, their number. Similarly, there is a range of potential detail with which to construct measures of living arrangements, with most research being based on binary or polychotomous categorizations. Specification and estimation of multivariate models are constrained not only by the degree of detail contained in the data, but also by the empirical frequencies of categories of potential interest. Thus, for example, the category "living with sister(s) but not others" may be of theoretical interest but observed so rarely in even a large sample that it cannot be distinguished in a model.

Since logit models have been most widely used to study living arrangements, the following discussion makes explicit use of the logit approach. Many (but not all) of the suggestions made would pertain equally to other approaches, such as probit. As is amply documented elsewhere, there are technical problems associated with the logistic model that might limit its applicability to the study of elderly living arrangements; [9] these technical issues are not, however, addressed here.

The most basic approach relates the type of living arrangement to an array of variables including measures of kin availability, possibly classified by type. In almost all cases the explanatory variables used pertain to the elderly person (or couple); measures of the number of children (or sons, daughters, married sons, unmarried sons, and so on) can readily be viewed as attributes of the elderly reference person. Such an approach has been called a "structural" analysis (see Soldo et al., 1990) since it relates family structure to household structure. For a binary representation of living arrangements (e.g., "alone" versus "with others"), unknown parameters consist of a single vector of coefficients on the measured attributes. For polychotomous coding of living arrangements (e.g., alone versus with child(ren) versus other) the model becomes multinomial logit (MNL), with unknowns consisting of vectors of coefficients on the measured attributes for all but one category of the living arrangements variable.

One variant on the structural approach, applicable to polychotomous outcomes, consists of imposing restrictions on the "choice" probabilities that reflect variations in kin availability in the sample (Wolf, 1984). For example, if the outcome is the trinomial variable with categories living

[9] In particular, the multinomial logit approach entails an "independence from irrelevant alternatives" assumption that might be viewed as overly restrictive; see Ben-Akiva and Lerman (1985).

alone, living with children, and other, but the sample contains elderly both with and without children, then constraints can be imposed such that the probability that a childless elder lives with children is identically zero. This restricted-probabilities approach has also been used in Martin (1989), Soldo et al. (1990), and Tsuya and Martin (1992). The alternatives to the approach include (1) performing separate analyses for subsamples defined according to the structure of the kin network; and (2) using all observations in a single model, without imposing the zero-probability restrictions mentioned above. The first alternative will often be infeasible since with the sample sizes commonly available subsets defined according to criteria such as, for example, "no children, one or more siblings," "no children, no siblings," and so on, will be too small to permit separate analysis. The second alternative leads to inefficient estimates (i.e., coefficients with standard errors that are too large) and, in addition, to inappropriate predictions (i.e., an elder with no living children is assigned a positive probability of living with children).

If available data contain some information about each living child (or about each person in any specified category of kin) a more complex approach can be used, one that utilizes all available information in the data even if the number of children (or other kin) differs across observations in the sample. The way in which the data might be used will depend, in part, on whether (and how much) multiple coresidence—that is, coresidence of the elder and two or more children at the same time—occurs in the data.

Case 1: No Multiple Coresidence If multiple coresidence does not occur in the sample, then a straightforward MNL specification can be used. Let the "dependent" variable *Y* be an indicator of which child the older parent coresides with, with $Y = 0$ denoting all "other" living arrangements; the notation for other variables is as defined above. Then the probability that the parent coresides with child *k* is given by the expression

$$pr(Y = k) = \frac{e^{A_1 X + B_1 S_k}}{1 + e^{A_1 X + B_1 S_1} + \ldots + e^{A_1 X + B_1 S_K}} . \quad (1)$$

Notice that this expression can accommodate families with differing numbers of living children (K). Note also that while parental characteristics, X, are constant over alternatives, the child characteristics, S_k, vary over alternatives. The "other" category can be further divided, for example into the categories "alone" and "other." The latter approach is found in Wolf and Soldo (1988), who use equation (1) as the basis for their analysis of the living arrangements of older unmarried women. The results consist of an array of coefficients on the older women's characteristics representing their effects on the log-odds of living with "others" (relative to living alone), an array of coefficients on the older women's characteristics representing their effects on the log-odds of living "with children" (relative to living alone), and an array of coefficients on child characteristics representing their effects on the log-odds that the parent and that particular child will coreside (relative to living alone). Interaction variables representing combinations of parental and child attributes can be added to this model; since they are child specific, they should be considered part of the array of child characteristics. Note also that this approach could be extended further so that individual children and individual siblings appeared as distinct potential coresidents, providing that it remained the case that there were no instances of multiple coresidence. The latter extension does not, however, appear to have been tried.

Case 2: Multiple Coresidence If simultaneous coresidence of elderly parent (s) with two or more children is sufficiently prevalent in a sample, then it may be possible to model the joint distribution of each child's coresidence behavior, and to identify parameters representing interaction effects between and among children's traits in the observed coresidence patterns. Suppose, for example, that there are just two children, to each of whom there corresponds a binary indicator of coresidence with the parent(s). If each coresidence indicator were independently determined, then we could derive a joint probability expression for any combination of the probabilities that $Y_1 = 0(1)$ and $Y_2 = 0(1)$ by multiplying together the respective binary logit expressions. The logit functional form has the advantageous property that the resulting product is conveniently in the MNL form. However, to accommodate the possibility that the two children's coresidence indicators are not independent, we add another term to the joint probability expression representing potential interaction effects, for example,

$$pr(Y_1 = 1 \cap Y_2 = 1) = \frac{e^{A_1X + B_1S_1 + A_1X + B_1S_2 + B_2D_{12}}}{1 + e^{A_1X + B_1S_1} + e^{A_1X + B_1S_2} + e^{A_1X + B_1S_1 + A_1X + B_1S_2 + B_2D_{12}}}, \quad (2)$$

in which the interaction effect is represented by the term B_2D_{12}, where B_2 is an array of coefficients and D_{12} is an array of variables representing interactions between the two children's characteristics or other variables describing the "duet" containing child 1 and child 2. There are four terms in the denominator of equation (2), one corresponding to each of the four possible coresidence patterns (neither child, child 1 only, child 2 only, both children). If the coefficient vector B_2 is found to be no different from zero, then the children's coresidence probabilities can be judged to be independent.

In practice, samples will contain older parents with one, two, three, and more children. Coresidence with none, one, two, three, or more children may also be observed. The approach outlined above can be extended to the more general case. It is necessary to enumerate all possible duets, all possible "trios," and so on; it is also necessary to derive variables capturing three-way interactions, four-way interactions, and so on. The number of conceptually permissible combinations becomes extremely large, so parsimony in the parameterization of the MNL probabilities becomes crucial. In order to keep analysis practicable, it may be necessary to limit the sample with respect to maximum size of kin groups and/or maximum number of recognized multiple coresidents.

The simultaneous logit approach just described has been applied by Ofstedal and Chi (1992), who analyze data from a recent survey of Taiwanese elderly. Ofstedal and Chi limit their analysis to a sample of 2,853 elders who coreside with zero, one, or two children. In this sample, multiple coresidence is fairly common: 20 percent of the elderly respondents are residing with two children simultaneously (the average number of living children in the sample analyzed is 4.61). The findings include three highly significant coefficients on "duet" variables, indicating that there are substantial interactions between individual children's coresidence behavior.

The preceding discussion pertains to "complete" kin sets, that is, to data containing at least some information about each member of a specified class of kin (e.g., children). Another type of data commonly used in research on elderly living arrangements comes from surveys in which the children of the elderly are respondents, providing information on the circumstances of their parents including coresidence status. Models developed for such data focus on the coresidence of a given parent-child pair, rather than whether or not coresidence with any child occurs. As an inevitable consequence of the way in which the data are collected, models of this sort tend to be richer with respect to their inclusion of relevant attributes of the child, but poor with respect to measures of the parent's attributes. Since the outcome is usually binary (child and parent coreside; other), binary logit or probit models are most often used in this research.

A Selective Survey of Findings Based on Microdata

The empirical literature on living arrangements of the elderly has grown rapidly in the last several years, so much so that it is impossible to present a comprehensive survey of the literature in these pages. The papers mentioned are all ones in which nationally representative samples were used, multivariate models were estimated, and at least some measure of current kin availability was included. These selection criteria exclude numerous papers of considerable interest, including several mainly descriptive studies of living arrangements among the elderly (see, for example, Link, 1987; Keilman, 1988; Schwartz, 1988; Wall, 1989; Grundy, 1992) and others using tabular approaches (e.g., Grundy and Harrop, 1992). Several otherwise informative multivariate analyses using the variable "children ever born" as a measure of kin availability (e.g., Avery et al., 1989; Burr and Mutchler, 1992; Wister and Burch, 1983) were also excluded by the above criteria. Even allowing for these admittedly arbitrary devices by which the field has been narrowed, the following survey does not claim to be complete.

Cross-Sectional Results Most of the available studies using microdata are cross-sectional in nature. We first consider several examples of what earlier were classified as "structural" analyses, that is, models in which the living arrangement outcome distinguished among categories according to the presence or absence of relatives by type, and some measures of the type of kin available for coresidence are included as covariates.

Selected features of a sample of such papers are summarized in Table 5-6. These papers represent analyses of several countries (although the United States is most heavily represented) and a narrow range of time periods, mostly in the 1980s. In the columns labeled "category of dependent variable" are numbers indicating the coding scheme for the dependent variable; thus a study represented by a 0 and a 1 in these columns uses a binary dependent variable, whereas others use 3- or 4-category outcomes as indicated.[10] All the studies shown happen to use logit (or MNL) as an estimation technique. The 0 category always represents the excluded category (i.e., the category for which logit coefficients are normalized to zero). The columns labeled "estimated effects of kin" summarize the estimated partial effects of kin availability in these studies, with an "x" indicating that the corresponding variable appears in the analysis without a statistically significant coefficient, while "-" and "+" entries indicate that statistically significant coefficients with the corresponding signs were found in the analysis. In reading these entries, an entry such as "+;-" means that the indicated variable had a significant positive coefficient in the outcome category coded 1 and a significant negative coefficient in the outcome category coded 2. For example, the first study mentioned, Bishop's 1986 article, uses a binary dependent variable with "alone" coded as 1 and "with others" coded as 0. The estimated effect of "number of children" on the log-odds of living alone (relative to with others) is negative and significant. A more complicated example is Wolf's 1984 study of Hungarian women. Here, a 4-category variable is used, with categories "alone" (coded 0), "with child" (coded 1), "with other relative" (coded 2), and "with others" (coded 3). The

[10] Some of the studies have living arrangement coding schemes more complex than indicated in Table 5-6; the table does, however, attempt to fairly represent the selected aspects of the studies that are presented.

TABLE 5-6 Summary of Findings from Structural Analyses of Living Arrangements of Elderly

		Category of Dependent Variable[a]						Estimated Effects of Kin[a]			
Study	Country; Year	Group[b]	Alone	With Spouse	With Child (only)	With Other Relative	With Others	Children	Sons	Daughters	Siblings
Bishop, 1986	United States; 1986	UmW	1				0	-			
		UmM	1				0	-			
Soldo et al., 1990	United States; 1982	UmW	0		1		2		x;x	+;-	
Wolf, 1990a	United States; 1984	UmW	1				0		-	-	-[c]
Stinner et al., 1990	United States; 1981	M	0			1		+[d]			
Wolf et al., 1990	Canada; 1985	UmW	0		1	2	3	+;-;x			x;x;+
Wolf, 1989b	Hungary; 1984	NmW	0		1	2	3	x;x;x			x;x;x
		WidW	0		1	2	3	+;-;-			-;-;x
		DivW	0		1	2	3	x;x;x			x;x;x
Martin, 1989	Korea; 1984	All	0	1	2		3	-;x[e];-			
	Malaysia; 1984	All	0	1	2		3	x;+[e];-			
	Philippines; 1984	All	0	1	2		3	-;+[e];-			
	Fiji; 1984	All	0	1	2		3	-;+[e];-			
Chan and DaVanzo, 1991	Malaysia; 1988-1989	M	0		1			+			
		W	0		1			+			

[a]For explanation of table entries see text.
[b]Div = divorced; Nm = never-married; Um = unmarried; Wid = widowed; M = men; W = women.
[c]Sisters only.
[d]Includes some cases with coresident nonrelatives.
[e]From separate binary analysis of "lives with child" outcome.

estimated effect of "number of children" on the log-odds of living "with child" (relative to "alone") is positive and significant, while the estimated effect of "number of children" on the log-odds of living "with other relative" (again, relative to "alone") is *negative* and significant.

Some of the studies shown have focused on the distinction between living alone and not alone (Bishop, 1986; Wolf, 1990a) whereas others have specifically identified living with child(ren) as a distinct type of living arrangement. However, in nearly all cases these research findings support the general conclusion that having more living children reduces the probability of living alone and increases the probability of living with children. This appears to be true in countries where coresidence of elderly with children is common (as in several Asian countries) and in countries such as the United States where coresidence is a minority phenomenon. Not shown in Table 5-6 (because it cannot be summarized easily in the format used there) is the study of Aquilino (1990), who uses NSFH data to analyze whether any children coreside with older parents, given that they have at least one unmarried adult child. In his results, it is not the number of children, but rather the characteristics of the pool of available children—especially age and marital status—that emerge as significant predictors of parent-child coresidence.

Analyses based on the restricted-probability variant of MNL described earlier also do not fit well in the format used in Table 5-6 since they do not necessarily produce coefficients directly representing the effects of kin availability. In Wolf (1984), for example, there are no coefficients representing the effect of having living children on the probability of living with a child (which is one of the outcome categories) since these effects are implicit in the probability expressions used in the estimation. It can be shown by using the results presented in Wolf (1984), however, that the differences in probabilities of each living arrangement type differ substantially according to whether or not there are living children. The same approach was used by Tsuya and Martin (1992), who employed data from a 1988 household survey conducted in Japan. Tsuya and Martin present a model based on five categories of living arrangements (alone; with spouse only; with unmarried children; with married children; with others), including observations with and without spouses, with and without unmarried children, and with and without married children, with appropriately constrained probabilities. Tsuya and Martin find several statistically significant "cross" effects; for example, the existence of unmarried children has a large negative effect on the probability of living with married children (-0.229), whereas the existence of married children has a smaller negative effect on the probability of living with unmarried children (-0.153).

Similarly, the "microanalytic" approach to modeling living arrangements, embodied in equation (1), does not necessarily produce coefficients indicating the effect of kin numbers on type of living arrangement. Rather, this model produces a set of probabilities of coresidence with each individual living child (which can be added to produce a predicted probability of living with a child under the maintained assumption of no multiple coresidence). The microanalytic approach does produce coefficients representing the effects on coresidence probabilities of individual attributes that may vary across children. This approach has, apparently, been employed only in Wolf and Soldo (1988), who use Shanas' 1975 data (Shanas, 1982). The results in Wolf and Soldo (1988) indicate that the child's sex and marital status matter (unmarried children are more likely coresidents than married children; daughters are more likely coresidents than sons; yet unmarried sons are the most likely type of coresident child among all sex/marital status combinations), as does the number of younger sisters (which reduces a given child's likelihood of coresidence, other factors being the same). Wolf and Soldo conclude that it is the composition, more than the sheer size, of the available kin network that helps explain variations in living arrangements.

So far we have considered only research in which the entire kin network (however poorly or incompletely measured) of an elderly person/couple is the unit of analysis. Such analyses have used data provided by elderly respondents and have tended to focus on consequences of variation in the availability of relatives, by type, for living arrangement outcomes. A different type of analysis uses data provided by the child of an elderly person, in which (in all such analyses to date) the dependent variable indicates whether or not that child and the parent coreside. Here, in other words, we examine the marginal probability of coresidence for a given parent-child pair rather than the probability of coresidence with each of (possibly) several children (or with any child). An important distinction to bear in mind is that in an analysis of marginal probabilities, the existence of the kin category in question (here, children) is built into the data analyzed, although variables indicating the existence of other kin can appear as covariates. The natural focus of the analysis tends to be on the importance of particular attributes of children and their parents to the probability of parent-child coresidence; the inherent weakness of such analyses is that they usually control inadequately, if at all, for the characteristics of siblings, who represent a pool of alternative parent-child coresidence options.

Among the extant examples of models of marginal parent-child coresidence probabilities are several articles using Japanese data (Bumpass, 1990; Kojima, 1992a,b; Martin and Tsuya, 1991), and an analysis of the NSFH data presented in Wolf et al. (1991a). Both of Kojima's papers, as well as Wolf et al. (1991a), focus on married couples, and distinguish between coresidence with husband's and wife's parents in the dependent variables analyzed; also, in both papers, covariates are included that represent the existence of siblings (and siblings-in-law), thus capturing some of the effects of variations in configurations of available kin. The model estimated in Wolf et al. (1991a) indicates that in most cases, the wife's elderly mother is a more likely coresident than the husband's. An exception to this, judged by predicted probabilities based on estimated coefficients, is the case in which the husband has no siblings but the wife does, and the husband's mother is in poor health but the wife's mother is in good health; in such circumstances, the husband's rather than the wife's mother is the more likely coresident. It should be noted, however, that in all cases, coresidence of either elderly mother with a married couple is a low-probability outcome.

A final model of this type is presented in Kotlikoff and Morris (1988), whose work is unique in that it uses data from paired interviews with elderly parents and one of their children. The drawback of the data is that they come from a small area sample of doubtful generalizability. Nonetheless, their study includes a better representation of parent and, simultaneously, child characteristics than is generally found in the literature. Of particular interest is the finding that the child's income has a positive effect on the log-odds that the parent lives alone, net of the (insignificant) effects of the parent's income. In virtually all the other studies cited here, in which income was included, only the parent's income was used in the analysis. In most such studies, it has been found that parental income is positively associated with living alone.

Models of Living Arrangements Transitions The availability of longitudinal data from several sources has led to a growing representation in the literature of papers analyzing transitions in the living arrangements of older persons. Some of the important multipurpose longitudinal data sources, such as the Survey of Income and Program Participation (SIPP), fail to include data on the existence of kin. Therefore, in keeping with the selection criteria used earlier, research on living arrangements based on the SIPP (e.g., Speare and Rendall, 1989; Mutchler, 1990) is not be discussed in detail. All of the studies cited use data from the United States.

An early analysis of living arrangement transitions is presented in Tissue and McCoy (1981), who used data from a sample of elderly welfare recipients interviewed in 1973 and 1974. Their analysis distinguishes between elderly living alone and those living with others, at baseline. Between baseline and follow-up, transitions due to arrival/departures of others, or of the respondent, can all be distinguished. A somewhat puzzling result (for which no interpretation is offered by Tissue and McCoy) is that among those living with others at baseline, the number of living children is positively associated with the respondents' moves out of the home occupied at baseline. It should be noted that the sample consisted of welfare recipients who experienced substantial income increases between the two inter views, as a consequence of the implementation of the Supplemental Security Income program.

Recently several studies of living arrangement transitions have appeared that use data from the LSOA. Of interest here are the findings concerning the effects of kin availability. Worobey and Angel (1990) use the 19841986 LSOA, which permits analysis of a single living arrangement transition for community residents at baseline, over a 2-year period. Their analysis is limited to unmarried elderly and consists of an ordered-logit model of a trichotomous variable measured in 1986 (0 = alone; 1 = with others: 2 = in institution). They find no effect of number of children on either of the two implied transition probabilities. Speare et al. (1991) also use the 19841986 LSOA, but include both married and unmarried elderly. In separate analyses of transitions from community to institutional arrangements, and of the probability of living with others in 1986 given the baseline living arrangement (which, in their model, implies four separate transition probabilities), they find no significant effects of number or sex composition of living children on transition probabilities. Spitze et al. (1992), who also use the 1984-1986 LSOA and consider only respondents unmarried at baseline, distinguish the following categories: alone, with children, with others, and in institution. Among those living alone in 1984, they find a significant positive effect of number of living children on the probability of a transition to the category of living with children, but no such effects for transitions to other categories. Among those living with children in 1984, no effects of number of children are found.

Recently, results have appeared based on the 1984-1986-1988 release of the LSOA. Angel et al. (1992) include married and unmarried respondents, and develop a model of living with others versus living alone in 1988. In this model, there is a significant effect of number of children (in 1984) on the probability of living with others in 1988. Although the model is not presented as a model of living arrangement transitions, it does (in one variant reported) include a control for living alone in 1986, from which transition probabilities can be inferred.

Assessment and Critique of Empirical Literature on Living Arrangements

The foregoing review of empirical literature is admittedly selective in its inclusion of papers and makes no attempt to provide a thorough survey of the findings reported in the selected papers. Instead, the intent has been to identify findings that relate to the central issues of this chapter, namely, the consequences of kin availability patterns for choices of living arrangements. In this narrow context, the following conclusions can be reached: First, observed living arrangements among the elderly are influenced by the size and composition of their available kin networks. Having more children makes coresidence with children more likely. Second, however, it seems clear that the characteristics of individual children strongly influence the observed coresidence outcome. More attention could, and should, be devoted to discovering the influence on living arrangement choices of particular traits of children (as well as of other kin) and, equally important, of the net effects of a given child trait in the specific context of a kin network containing other children, each having particular traits. Methods that permit such analyses are more complex than those generally encountered in the literature, but they are available.

In connection with this need for increased use of what has been called the microanalytic approach to modeling living arrangements, it can be noted that existing data have been underutilized. Aquilino (1990), for example, reduces the child-specific information found in the NSFH into several summary indicators of the set of children as a whole (e.g., age of youngest child, number of sons, number of never-married children, and so on).

It is also possible, in some cases, to construct child-specific variables even if the underlying data are not collected in this way. In the 1984 SOA, for example, the variables "number of living sons" and "number of living daughters" can be found. A household roster, containing a "relationship to respondent" code for every household member, is also part of these data. Therefore it can be determined whether the respondent lives with a daughter or a son. However, even with this limited information it is a simple task to create K arrays of child characteristic variables (the S_k arrays defined above), each of which contains variables indicating the sex of that child, whether (and how many) brothers that child has, and whether (and how many) sisters that child has. Finally, if there is a coresident son (daughter), one of the S_k arrays coded as son (daughter) can arbitrarily have associated with it an indicator of coresidence with the parent. Now, the MNL approach shown as equation (1) can be used with the rearranged data. This approach will work as long as there are not two or more coresident children, and it makes much fuller use of the data than the simpler structural approach.

Importance of Controlling for Income and Disability/Health Most of the papers cited above include some measure of health and/or functional limitation status, as well as income, for the elderly parent. Such variables are clearly theoretically relevant as suggested by the discussion of conceptual issues. Two points need to be made about these variables, however. First, if an analysis fails to control for health/disability and/or income, then biased estimates of the effects of kin availability variables may be obtained, because there is likely to be a correlation between family composition and income, and between family composition and health status. Higher-income people, for example, may have fewer children, and have higher incomes both during childbearing years and in old age; also people with more children may also save less when young, leading to lower retirement incomes. Such considerations imply a need for a concern with omitted-variable bias in the estimated effects of kin structures on living arrangements.

A second point with respect to controls for health/disability status can also be made. Most studies have included measures of functional limitations in the form of simple counts of Activities of Daily Living (ADL) and/ or Instrumental Activities of Daily Living (IADL) that are difficult or impossible for the elders being studied. Yet there is some evidence that different specific types of functional impairment have differential impacts on living arrangement choices. In a study of the dichotomous outcome of living alone versus living with others, Wolf (1990a) addressed this question using Canadian and U.S. data. In the Canadian sample it was possible to control separately for whether respondents were unable to perform any of the following four tasks: meal preparation, money management, light housework, and grocery shopping. In the U.S. sample (from the 1984 SOA) an array of dummy variables was used to represent individually each of six ADL and six IADL limitations.

The results of these more detailed regressions are striking. In the equation based on the SOA, *none* of the indicators of ADL limitations was associated with living alone. On the other hand, difficulties with three of the IADL tasks—meal preparation, money management, and the use of the telephone—were found to significantly reduce the odds of living alone. In the Canadian equation, variables indicating the inability to prepare meals and to do grocery shopping were significantly associated with a reduced likelihood of living alone. These findings suggest the fruitfulness of a closer examination of associations between specific functional limitations and decisions regarding living arrangements.

Additional Methodological Problems In addition to the problems already discussed, a few others can be mentioned in brief. First is the issue of possible endogeneity bias in models of living arrangements. Some analyses have included variables representing the employment status of adult children with whom an older parent might coreside (Wolf and Soldo, 1988). This variable is potentially endogenous, since a child (e.g., a married daughter) might simultaneously reduce employment and begin a period of coresidence with her elderly mother. In the absence of a formal test of exogeneity, another strategy is to control, instead, for the child's potential market wage (i.e., for the exogenous determinant of the child's employment status; see, for example, Wolf et al., 199 a).

Finally, most of the cross-sectional research available thus far is based on samples drawn exclusively from the noninstitutionalized population. At successively older ages a higher proportion of the elderly population is, however, found in nursing homes. There is some evidence that transitions into and out of nursing homes are influenced, in part, by family structure (see, for example, Garber and McCurdy, 1989, or Freedman, 1993). Consequently, great care should be exercised when attempting to infer global patterns of association between kin patterns and living arrangements from research derived from samples likely to be selective with respect to the availability of familial resources.

PROXIMITY

We turn now to the issue of spatial proximity of the elderly and their kin. Proximity to kin is related to kin availability both in a trivial way—kin proximity is impossible without kin availability—and, less trivially, through any effects of the size and composition of kin networks on the spatial distribution of kin from the vantage point of an elderly person. Proximity is also related to living arrangements, in the sense that nearby kin can in many respects provide the same benefits as coresident kin. In fact, among the motivations thought to influence both migration behavior and living arrangement choices is a preference on the part of the elderly for living near (but not with) their children, for having (in the often quoted phrase of Rosenmayr and Köckeis, 1963) "... intimacy at a distance." The elderly's preferences for residential propinquity have been confirmed in many studies (e.g., Day, 1991; for several early citations, see Troll, 1971:265-266). Moreover, parents (and children) might hold norms of responsibility for mutual assistance among family members, suggesting that spatial proximity is maintained in order to facilitate such normative behavior (for a review, see Mancini and Bleiszner, 1989). There is ample empirical evidence of the importance of proximity in the actual mobilization of such resources. For example, the distance between a parent and a child is strongly (and negatively) related to whether the child performs household chores and provides other assistance, and to the frequency of contact between the two (Crimmins and Ingegneri, 1990).

Since parents and their children nearly always coreside at the time of the child's birth, it is plain that parent-child proximity late in the parents' lives must be the consequence of the subsequent migratory behavior of both the parents and their children. However, the spatial distribution of kin also influences individual migration behavior over the life course. Therefore, kin proximity is both cause and consequence of migration behavior among network members. The following review considers empirical findings both on the importance of proximity in migration outcomes and on cross-sectional patterns of kin proximity, as they relate to migration behavior and other factors. Nearly all the relevant research has addressed the proximity of elderly and their children, rather than the wider kin network, and this limitation is reflected in the following discussion.

Elderly Migration as a Means of Achieving Proximity to Kin

Migration of the elderly has generally been divided into two broad classes. The first, "voluntary migration," consists of moves toward a more attractive location, such as moves associated with retirement. Those making such moves tend to be "young-old," married, well off, healthy, and well educated, and to have moved often (Wiseman and Roseman, 1979; Parker and Serow, 1983; Meyer and Speare, 1985; Litwak and Longino, 1987; Speare and Meyer, 1988). The second type of elderly migration is associated with an inability to care for oneself without help. These migrants tend to be older, less well off, in worse health, and widowed. Such moves may occur in stages. Speare and Meyer (1988) assert that some elderly move in anticipation of later care needs. Moves, possibly toward children, may also take place when an older person actually becomes disabled or widowed— which may mean losing a caretaker (Parker and Serow, 1983; Litwak and Longino, 1987; Longino, 1990). A final type of health-related move, which may follow the development of major chronic disability, is into an institution (Litwak and Longino, 1987; Longino, 1990).

Empirical Research on Parent-Child Proximity

As the preceding discussion shows, parent-child proximity is valued (by the parents, at least), and has important consequences with respect to helping behavior and other forms of contact. The obvious interrelationship between proximity and migration has been noted. There has, however, been relatively little research in which proximity itself has been the outcome of interest. Even more rarely has research attempted to examine directly the extent to which proximity to kin results from migratory behavior by parents and/or children.

Important contributions to the literature on parent-child proximity and migration have been made by Warnes and colleagues. Law and Warnes (1982) analyze retirement decisions, using samples of migrants and nonmigrants taken in two areas of England during 1976. Law and Warnes demonstrate the importance of kin proximity both in the decision whether to migrate and in destination choices among migrants. For example, 21 percent of migrants stated that the main reason for moving was to be nearer to children or friends while a majority of the nonmigrants gave as a reason for not moving the desire to remain in proximity to children, friends, or other relatives (Law and Warnes, 1982:74).

In a subsequent paper, Warnes (1986) examines data from a somewhat specialized sample, one containing 432 English couples (at least one member of which is of pensionable age), each of which has exactly two living children. The data measure current proximity and also provide unusually complete migration histories. Several regression results are presented, in which the dependent variable is the (log) distance between parents and children; a consistent result is that moves made by the *child* increase the distance between parents and children.

The NSFH data, already described, include information on distance to nonresident parents and children. These data have been used in proximity models by Clark and Wolf (1992) and by Rogerson et al. (1993). Clark and Wolf use only those NSFH observations in which the respondent is 60 or older. In using this subsample, two types of logistic regression analysis are performed: the first uses as its dependent variable an indicator of whether the respondent has any nearby children (i.e., an indicator of whether the nearest child is "near"; defined as living within 10 miles of the respondent); the second uses the same underlying data but treats each parent-child pair as a separate observation. In each such parent-child pair, the dependent variable is an indicator of whether the child in question lives near the respondent. In this case, each child's proximity to his or her parent is treated as an independent outcome. The first model allows for simultaneity in children's proximity outcomes, without explicitly specifying the form of any such simultaneity, whereas the second model implicitly assumes away any simultaneity, and thus is restricted to providing inferences concerning the correlates of a child's *marginal* probability of living close to his or her parent. Finally, in Clark and Wolf (1992) the proximity measure studied is a binary indicator: coresident parent-child households are included in the near category.

The findings reported by Clark and Wolf (1992) can be summarized as follows: parents with more resources—whether these resources are relative youth, high levels of educational attainment, or a living spouse—are less likely to live near a child than parents with fewer such resources. The more children an older respondent has, the more likely it is that he or she will live near at least one child. Having a married child—who presumably has competing obligations—reduces the likelihood of living near at least one child. Parents with never-married children are more likely to live near a child than those without, but this appears to be the result of the relative youthfulness of unmarried children, rather than their marital status, per se. Among the young-old, migrants are less likely than nonmigrants to live near a child, but by age 77 those who have moved within the last 5 years are more likely to live near a child than those who have not migrated. Children's characteristics are important in determining which child an elderly person lives near. In general, as children age and marry, they are less likely to live near their parents. However, a reversal occurs when the children them selves have children: having two or more children has a positive effect on proximity to parents that outweighs the negative effect of being married.

In contrast to the Clark and Wolf study, Rogerson et al. (1993) use NSFH respondents who have living parents and thus analyze proximity of parent-child pairs using information provided by the child. Instead of a categorical indicator of proximity, Rogerson et al. use the natural logarithm of distance (in miles) from the respondent to the relevant parent, reporting separate analyses of those with (1) both parents alive and married to each other, (2) mother only alive, (3) father only alive, and (4) both parents alive, but not married to each other. For the latter group, separate regressions for distance to father and distance to mother are reported. Rogerson et al. also exclude from their analyses respondents who are coresiding with their parent. Although the same variables are not always significant in the five regressions reported, several patterns emerge from the findings. For example, respondents currently enrolled in college generally live farther from their parent(s) than others, and residents of the West consistently live farther from their parents. Migration history plays a role here as well: the greater is the distance of the child's most recent move, the greater is the distance to the parent (consistent with the result reported in Warnes, 1986). Offsetting this is a timing effect: the longer the time spent at the current address, the less is the distance to the parent or parents. In three of the five regressions, age (of respondent) has a significant effect: older children live farther from their parents than younger children, on average. The latter finding agrees with those in Clark and Wolf. Other points of comparability are more difficult to establish, due to differences in model specification and variable coding.

Taken together, the Clark and Wolf (1992) and Rogerson et al. (1993) findings suggest an image of children who make geographic moves that remove them from close proximity to their parents; later, the parents make moves that again bring them into closer proximity. Whether parents indeed chase their children from location to location (and the prevalence of such a pattern, if it does occur) is an issue that must be addressed by using linked migration histories of parents and children; it cannot be addressed satisfactorily by using current proximity data.

A final comment concerns the use of proximity as a covariate. Several studies have used proximity as one of several covariates in multivariate analyses of outcomes such as intergenerational resource flows (Eggebeen, 1992; Hoyert, 1991) and the provision of care by adult children to elderly parents (Lee et al., 1993). The preceding discussion suggests that proximity is itself an outcome, one resulting from the combined behavioral choices of parents and their children, and one motivated in part by the desire to facilitate intergenerational contact and/or resource flows. If so, then proximity should not be treated as an exogenous covariate, but rather as an outcome jointly determined with the resource flow being examined.

CONCLUSION

At various points in this chapter, assorted deficiencies in the existing literature concerning kin availability, living arrangements of the elderly, and spatial proximity of elderly and their kin have been noted. These are not repeated here; rather, it is noted that they constitute a familiar litany: there is a need for more powerful theories, better data, improved methodologies, and more comprehensive empirical research.

The foregoing review does suggest a number of areas in which future research could make useful contributions. For example, despite the limitations of existing data, the data in hand have not been utilized fully. For purposes of description, the development of new indices or other ways to represent the composition of kin networks—including, perhaps, graphical methods—would be of great value. From a methodological standpoint, existing data could be used to support more complex and detailed representations of the linkages between kin availability (as determinants) and living or proximity outcomes (as consequences). Indeed, complexity is a recurring theme in the literature on kinship patterns and their consequences, suggesting that efforts to promote and enhance the use of methods appropriate for complexities such as these would be of great value.

The development of theoretical tools for analyzing kin networks would also be welcome. Of particular value would be the development of models of decision making in diffuse kin networks. Microeconomic theories have, for example, been extended beyond simple models of individual choice to more complex models placed in a household setting, including models in which individual preferences may be in conflict. Decisions involving potential migratory behavior, in combination with coresidence or close spatial proximity of an elderly parent and one or more of their children, are more complex still and require consideration of a broader array of preferences and constraints.

I will close with a question not previously addressed, one that is entirely speculative in nature. In particular, trends over time in living arrangements (and, for that matter, in kin proximity) are readily analyzed as the consequence of other, more fundamental, trends such as changing family size (i.e., changing fertility patterns in earlier times), rising income, and possibly improved health. The observed trends could easily be thought to be the result of choices that reflect *fixed* preferences (or, alternatively, behavioral "propensities") in combination with a *changing* composition of the population making those choices. A larger, and considerably more difficult, issue is the question of feedback effects: As the age structure of the popu lation (an aggregate phenomenon) changes, becoming more aged, will the decision parameters of the elderly (or of their children) change? Will a greater prevalence of older people translate into altered norms governing intergenerational relations at the individual-, kin network level? These are questions that lend themselves less readily to empirical research of the sort given most attention in the present paper, but are offered as a potentially fruitful area for future research.

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6

Care of the Elderly: Division of Labor Among the Family, Market, and State

Beth J. Soldo and Vicki A. Freedman

INTRODUCTION

Although disability is not the inevitable consequence of human aging, the risks for both chronic disease and disability are highly age related (Manton and Stallard, this volume). Because of this, the aging of the U.S. population as a whole and the implosive growth of the very oldest segments within it are associated with an increased demand for all types of health care, including nonmedical personal care (Suzman et al., 1992). As shown in Table 6-1, the current demand for such care is substantial. In 1985, nearly one in five (19.2%) persons aged 65 and over was disabled but living in the community, while another 5 percent were disabled and institutionalized, mostly in nursing homes. The vast majority of these disabled elderly call on informal sources of support—family and friends—to assist them. At any point in time, however, slightly more than 5 percent of the elderly are disabled and rely in whole or in part on paid helpers in the community. In all, nearly 7 million older persons, or about 24 percent of all elderly, are disabled in some way.

Personal care is assistance that compensates for chronic limitations in basic self-care activities, such as shopping, meal preparation, eating, bathing, or dressing (Soldo et al., 1989). Because it is inherently a nontechnical service bundle, no one social institution claims unique competency in its

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provision. As a result there is no natural division of labor among family care givers, private pay helpers recruited from the marketplace, and state subsidized providers in meeting the nonmedical care needs of the elderly.

TABLE 6-1 Disability and Care Arrangements of the Elderly Population, 1985

	Percentage	*N* (thousands)
Community		
Nondisabled	76.3	21,761
Disabled	19.2	5,465
Informal only	13.5	3,853
Formal only	1.2	344
Informal + formal	4.5	1,273
Institutionalized	4.6	1,310
Total	100.0	28,536

SOURCES: Manton (1989); Soldo et al. (1989).

In this chapter we explore the alliance of the three major sources of personal care in the U.S.: the family, the marketplace, and the state. By *family* we mean the network of relations and obligations defined by blood, marriage, or adoption and not simply the family of coresidence. We confine our attention to parent-adult child relations [1] and acknowledge that both generations may be deemed elderly in terms of chronological age.[2] The

[1] Although most elderly have at least one sibling (Cicirelli, 1985), siblings are far more likely to provide emotional support and companionship than hands-on personal care. Children are considerably more likely to be the major source of assistance to the frail elderly largely because same-aged kin (spouses as well as siblings) are exposed to similar risks of morbidity and mortality (Scott, 1983).

[2] Recent sociodemographic trends have converged in a way that blurs the distinction between age and generational status. Among the more important of these trends are secular declines in fertility, unanticipated improvements in old-age life expectancy (Manton and Soldo, 1985), increased incidence of divorce, and disruptions in the "normal" order of some life-cycle events (Rindfuss et al., 1987). In combination, these trends have (a) "verticalized" the contemporary kin network (Bengtson and Dannefer, 1988) by increasing the number of coexisting generations even while the size of the nuclear family within a generation declines; (b) extended long-term intergenerational bonds, allowing for the possibility of "life overlaps" (Hagestad, 1986) where a single life-cycle stage encompasses two generations; and (c) increased the complexity and diversity of kin networks through the dissolution and reformation of families within a generation, thereby creating a matrix of latent kin relationships (Riley, 1983).

market refers to the private sector in which consumption is determined largely by price. Our notion of the *state* is broad and references a variety of structured intergenerational transfer programs under the aegis of federal, state, and local governments. For the most part, the state provides personal care indirectly by subsidizing market transactions. Of particular interest in this chapter are how the volume and type of care and support received by older persons is distributed across these sectors, and the range of factors that affect this distribution.

Demographic interest in the division of labor between the family and other sectors of society is fairly recent and largely confined to research on the child care arrangements of working mothers (see, for example, Liebowitz et al., 1988). But population aging requires a society to focus on the dependencies of both the very young and the very old. The needs of the young and the old are not equivalent; societal strategies for accommodating dependency are thus transformed in the wake of population aging.

At least in general principle, the division of labor among the various sectors of society in providing for the needs of the young is well established. Parents bear primary responsibility for socializing children and providing them with basic care and amenities. Other child care arrangements are viewed as alternatives for which parents still bear primary responsibility. Through various structured intergenerational transfers (e.g., property and income tax) the state provides or regulates formal education. The public sector also subsumes or shares aspects of parental responsibilities in some instances of social or economic incapacity. In contrast, the lines partitioning responsibility for the daily care and well-being of the elderly are not as cleanly drawn.

Understanding how social institutions adapt to population aging can be approached from either a macro- and a micro-level perspective. The chapter by Lee in this volume provides a macro account of intergenerational transfers that bear on society's adaptation to an older population. This chapter largely considers the micro-level features of these emerging accommodations in the United States.

SUBSTITUTIONS

Because we consider the division of labor between the family and the state in the context of a market economy, issues of substitution emerge. Financial transfers from either the family or the state may be used to purchase care services in the marketplace. *Inter vivos* financial transfers to the frail elderly and their claims on structured programs augment their own privately held economic resources, including those that result from past employment, consumption, and savings, as well as private pensions, housing equity, and consumer durables.[3]

TABLE 6-2 Potential Substitutions of Time and Financial Transfers Within and Across the Family, Market, and State: Personal Care for Disabled Elderly

	Sectors		
Currency of Transfer	Family	Market	State
Provision of services	Informal care	Formal care Paid providers	Local area programs
Financing of services	Subsidized market transactions through direct payment to providers	Long-term care insurance; home equity conversion	Subsidized market transaction through Medicare and/or Medicaid

Table 6-2 lists potential substitutions involving the family, market, and state in two of the currencies of *inter vivos* transfers: time and money. Potential substitutions can be identified by reading this table vertically or horizontally. We focus on only two types of substitution: (1) substitution involving transfers in the same currency across sectors (e.g., the substitution of services purchased in the marketplace for family services) and (2) substitutions in different transfer currencies within a sector (e.g., substitutions of *inter vivos* family financial transfers for the family's time). The former type of substitution results from the family sharing its traditional responsibilities for the care of dependents with the marketplace and state whereas substitution of the latter type arises from the opportunities afforded by the marketplace to convert money into (purchased) time.

Reading across the columns of Table 6-2 suggests the scope of potential substitutions across the three sectors. A frail older person can recruit family members to provide the necessary personal care; purchase private care

[3] Financial transfers from family and state benefits are not truly independent alternatives for the elderly whose own resources are inadequate to purchase care services in the marketplace. Although receipt of some benefits, such as those from the Medicare and Social Security programs, is conditional only on age and/or past employment history, other benefits, such as those from Medicaid and the Supplementary Security Income programs, are means tested, requiring depletion of resources. Income flows from family are figured into the income base by these latter programs. Welfare rules in some states also take account of coresidence in determining eligibility or benefit levels (Hill, 1990).

or assistive technologies (LaPlante et al., 1992); or avail him or herself of the limited number of state-funded programs, such as those providing geriatric adult day care.[4] Reading down the rows highlights the nature of substitution from the perspective of the provider. A family can respond to a parent's need for personal care, for example, by providing hands-on care directly or by financing the purchase of such care, either at home or in the nursing home. The marketplace also offers both service and financing options. In increasing numbers, private home health agencies provide a range of fee-for-service options to the frail elderly as do independently employed home health aides (Estes and Swan, 1992). Insurance for long-term care, a relatively new product of that industry, underwrites some of the costs of community care and nursing home care for a limited number of subscribers (Meiners and Greenberg, 1989; Cohen et al., 1992). The state's response to the personal care needs of its older dependents is confined largely to subsidizing the costs of such care through the reimbursement of services under a capped schedule of fees.[5]

By focusing only on personal care we mask an important aspect of *inter vivos* transfers: transfers responsive to one area of need often yield secondary benefits. By coresiding with an adult child, a frail parent, for example, receives implicit service and financial benefits (Morgan, 1983; Cox and Raines, 1985; Burch and Matthews, 1987; Jackson et al., 1991). Direct financial transfers from one or more children can supplement the parent's disposable income with which market services or other amenities can be purchased. In theory, the family also can provide an older parent with an annuity that serves the same function as regular out-of-pocket transfers to the parent.[6] Similarly, market substitutes for income maintenance (private pensions, trusts, and other assets) can be directed to the purchase of needed services or other expenditures. Considering the ways in which transfers

[4] There are very few publicly financed nursing homes operating in the United States. Veterans Administration nursing homes are a notable exception. Many communities run programs, which typically offer a range of services (such as home-delivered meals, transportation assistance, chore services, and case management) and benefit from public funding through Title XX of the Social Security Act and the through the Older Americans Act.

[5] The major public programs paying for care services for the elderly have large gaps in coverage of chronic, personal care services. Medicare covers only those long-term care services associated with acute episodes. Skilled nursing facilities are covered up to 100 days, along with home health for recovery purposes. Medicaid covers unlimited nursing home and home health care visits; however individuals are required to spend down assets to become eligible for coverage. Other federal programs, provided under the Older Americans Act and Title XX of the Social Security Act, provide care services directly on a limited basis in the form of nutritional and social services (Davis and Rowland, 1986).

[6] Altonji et al. (1992), however, reject the hypothesis of family risk-sharing behavior.

convey side benefits responsive to areas of need other than personal care is beyond the scope of this chapter.

In the following sections we consider two types of substitution that have received considerable research attention from diverse disciplines: the substitution of paid providers for family care and the substitution of family financial transfers for their time. For each type of substitution we identify unresolved conceptual and methodological issues.

Substitution of Paid Providers for Family Care

Research on the substitution of formal care for informal care has been motivated by two related concerns. First, demographic trends portend a reduction in the supply of informal helpers, particularly the adult daughters of widowed or divorced older persons, as the family size of the elderly declines in the next century (Treas, 1977; Doty, 1986; Himes, 1992). Sustained labor-force participation by adult daughters of the frail elderly may further deplete the potential supply of care providers. Second, and more distinctively a policy concern, is apprehension of a possible "woodworking" effect if state subsidized home care benefits were to encourage family helpers to withdraw or reduce their efforts in response to a decline in the price of purchased care.

For the most part, the gerontological literature has concerned itself with the substitution of market (or "formal") services for family (or "informal") care (Moscovice et al., 1988). As commonly used in this literature, market services refer to the assistance provided by both paid helpers with various levels of training and volunteers from community programs.[7] Thus this literature blurs the distinction between private pay market services and state subsidized transactions in the marketplace.

Numerous studies based on national samples using various definitions of disability show that the bulk of personal care received by the frail elderly in the community is provided without compulsion or compensation by family (Branch and Jette, 1983; Stone et al., 1987; Soldo et al., 1989). Family helpers also are the providers preferred by the elderly themselves (McAuley and Blieszner, 1985). Kin are recruited to care giving much along the lines postulated by Cantor's (1979) theory of "hierarchial compensation" with

[7] Defining "formal care providers" solely in terms of nonprimary group relations results in a grouping that is both ambiguous and heterogeneous. To overcome this imprecision, various researchers have introduced other considerations. Litwak (1986), for example, equates formal helpers with those recruited from structured bureaucracies whose organization reflects an ideology of rationality and efficiency. The term "paid helper" (which includes compensated but unskilled home health aides as well as skilled providers delivering in-home medical care) has largely replaced the less precise term "formal helper" in policy research (Liu et al., 1985).

the spouse as the preferred provider, followed by children in the absence of a spouse, and distant relatives and friends as a last alternative for the unmarried, childless elderly. There also are distinct racial and ethnic variations in helping patterns (Mutran, 1985; Jackson, et al., 1992).

As shown in Table 6-1, only about one in four disabled elderly in the community depend in whole or in part on paid helpers (Liu et al., 1985). Approximately 3.3 million disabled elderly were estimated to have had at least some episodes of paid care in 1988, which generated $3.1 billion in out-of-pocket costs for the frail elderly and their families (Wiener and Hanley, 1992). Like other forms of health care, the consumption of formal community care services is highly skewed. Using data from the National Long-term Care Demonstration (Applebaum, 1988), Kemper (1992) estimates that the top 10 percent of formal care users consume 63 percent of all paid care.[8]

An ongoing debate over what constitutes in-home or personal care is reflected in alternative definitions of care found in prior studies of substitution in the gerontologic literature. Kemper's (1992) definition of personal care is broad and includes in-home assistance with both medical treatments and services supportive of daily functioning. Tennstedt and McKinlay (1986) argue, however, that in-home medical care is inconsistent with the notion of personal care, and in subsequent analyses they exclude health care professionals from their inventory of formal helpers (Tennstedt and McKinlay, 1989; Tennstedt et al., 1992). Neither has consensus emerged in the aging research literature on the exact meaning of substitution.

In an economic sense, substitution refers to an increased demand for good $x_1$consequent to an increase in the price for good x_2 (Varian, 1990).[9] In extending this framework to the care arrangements of the disabled elderly, family care and market care are assumed to be two distinct goods. The demand for these goods may be measured in a variety of ways, such as hours of help per day, days of help per week (Christianson, 1988; Edelman and Hughes, 1990; Hanley et al., 1991; Tennstedt et al., 1992), or number of tasks with which assistance is provided (Greene, 1983). The price of family care may be proxied by the value of family members' time in the

[8] The National Long-term Care Demonstration is a 10-site project in which publicly subsidized care services were made available to older persons deemed to be at risk for nursing home admission.

[9] In the simplest case of perfect substitution, an individual chooses not to buy any of x_1 if its price (p_1) exceeds the price of the second good (p_2); if $p_1 < p_2$, the individual will buy m/p_1 units of the first good, where m is the budget constraint. More realistic is the notion of imperfect substitution, which implies that the demand for a good (x_1) will increase if the price of an alternative good increases. Formally, the first good is a substitute for the second if

$$\Delta x_1/\Delta p_2 > 0.$$

marketplace (opportunity costs), while the price of formal care often is equated with out-of-pocket costs. In an economic sense, formal care would be seen as a substitute for informal care if changes in the price of formal care are positively associated with the demand for informal care.

Whereas economics has a precise definition of substitution embedded in a theoretical formulation of marginal utility, the concept of substitution as typically used in the gerontological literature refers to a discrete trade-off or simple replacement of family care by market care. Analogues to the notion of price elasticity are implicit in most prior research. Although seldom developed in any detail, the tacit hypothesis is that as care needs increase, the "price" of informal care (measured in terms of caregiver burden or foregone wages) increases and the demand for market care alternatives increases as well. Most often, the demand for such care is equated with the actual use of these services.[10]

In practice, studies of substitution of formal for informal care have not explicitly modeled the price of alternative goods, or the budget constraints on the disabled individual or on his or her family. Instead, the *demand* for formal care—usually proxied simply by utilization—often is used to predict the level of family care (see, for example, Tennstedt and McKinlay, 1989). Although there also are numerous instances in which family care has been used to explain the demand for paid care (Soldo, 1985; Wan, 1987; Coughlin et al., 1990), the major policy focus has been on how formal care affects levels of family care. Because the price and the demand for a good are typically related indirectly, substitution between formal and family care is inferred if an increased use of paid care is inversely associated with the volume of family care consumed.

Neglecting for a moment the potential substitution of nursing home care for any type of community care, it is likely that disabled elderly and their families decide how much total care they prefer to consume and the preferred mix of providers, subject to a variety of constraints. Simple cross-sectional regression models predicting the receipt or level of family care can not render this simultaneity. More sophisticated approaches for cross-sectional data have been described by Greene (1983) and Hanley and colleagues (1991) who jointly model the use of formal and family care with

[10] Weissert and colleagues (1988), for example, identified some 53 experimental studies of the effect of formal community care on the level of informal care. Their conclusions are expressed in terms of the simple use of services (i.e., "informal social support tended to decline with home and community care use"). More recently, Weiner and Hanley (1992) have challenged these findings on the grounds that there were not significant reductions in the total volume of informal care across *all* areas of need.

multistage estimation procedures. Such studies find limited evidence for the substitution of paid care for family care.

Many of the deficiencies found in the existing literature on the substitution of market services for family care reflect nascent theoretical accounts of the demand for personal care in general. Although analysts inevitably model the use of care services as a function of need (usually indexed by physical or cognitive limitations in basic self-care activities) and the individual's economic resources[11] (usually measured only in terms of annual income), treatments of price and supply factors differ markedly.

Consider first approaches for indexing the potential supply of care providers, both family helpers and paid helpers. Although early models of family caregiving commonly omitted any measure of the potential supply of family helpers, more recent analyses include at least crude measures of family structure (such as the "number of daughters") as proxy measures of supply. Even with summary measures of family structure, most prior studies estimate what might be deemed "demand" models of care. A distinctive, albeit implicit, feature of such models is viewing the beneficiary of the transfer as the sole decision maker (i.e., the use of any kind of care is determined only by the beneficiary's need and budget constraints). By ignoring constraints on potential donors of care, demand-based models inevitably treat kin as interchangeable resources for the frail elderly in spite of accumulating evidence to the contrary (Soldo et al., 1990).[12]

With the advent of data that link attributes of adult children living both inside and outside a parent's household to the specific care behaviors of each child, more realistic models of the full range of transfers are possible (see, for example, Wolf and Soldo, 1990). Yet in cross section, such data pose formidable statistical problems. At a point in time the attributes representing the constraints on potential providers, such as employment, child care responsibilities, and proximity, are endogenous with the elder care outcomes of interest (Wolf and Soldo, in press). Nonetheless, such data bases provide the opportunity to model the use of care services as the outcome of a joint decision-making process involving both the frail elderly and the potential kin donors of care. They also allow for models in which the care decisions of one potential provider are conditional on the behaviors of other possible providers of care, including paid helpers. Such models can be extended to test theories of joint family decision making by taking

[11] In-home care by paid helpers is assumed to be a normal good (i.e., other things being equal, individuals will consume more paid care as income rises).

[12] Coward and Dwyer (1990) also have examined the extent to which adult children are interchangeable resources for parent care, although their model assumes independence of the behavior of each child. In combination with Soldo et al. (1990) these studies indicate, however, that the characteristics of others within the pool of potentially available helpers largely determine which child has primary responsibility for the personal care of a parent.

into account not only the constraints on each potential helper but also purchased care alternatives.

TABLE 6-3 Predicted Probabilities of Caregiving by Various Types of Helpers, by Level of Need: Widowed Mothers with Two Children (an unmarried son and an unmarried daughter)

	Level of Mother's Need			
Predicted Probabilities	IADL Only	1-2 ADL	3-4 ADL	5-6 ADL
Primary caregiver[a]				
P (child)	.504	.424	.375	.346
P (paid)	.140	.197	.287	.354
P (other)	.298	.309	.304	.295
Care involvement[b]				
P (child)	.701	.642	.652	.664
P (paid)	.222	.305	.446	.575
P (other)	.500	.549	.614	.624

Table 6-3 illustrates the potential of models that exploit linked child and caregiver rosters by simultaneously taking into account: (1) the needs and resources of an older parent and his or her array of potential providers (the option set); (2) the underlying process by which the care involvement of one child is conditional on the behaviors of other adult children; and (3) the potential substitution of paid helpers for informal care. The predicted probabilities shown in Table 6-3 were estimated under a five-tiered model of the care networks of elderly, widowed mothers living in the community in 1982 (Wolf and Soldo, 1990).[13] For purposes of this illustration, the

NOTE: ADL = Activity of daily living; IADL = Instrumental activity of daily living.

[a] Primary caregiver defined by respondent report of frequency and level of help from each provider.

[b] Probability that a provider of a specified type will appear anywhere in the care network.

SOURCES: Predicted probabilities estimated under the model described by Wolf and Soldo (1990). Data are from the 1982 National Long-Term Care Survey (Macken, 1986).

[13] The model estimated uses a multinomial specification of care behaviors and assumes a hierarchical rather than a simultaneous decision-making process. Effects were estimated for the first five levels of care graded by the intensity of the care given. Caregivers at the first level of the hierarchy are termed primary caregivers. The estimated model includes indicators of the mother's needs (functional limitations and cognitive impairments), her resources (income and housing equity), and basic demographic traits of each child available for parent care at each level of the model. A child assigned the primary caregiver role at the first level of the model is considered ineligible to provide lower levels of care. The sole indicator of the price of paid care is the mother's current Medicaid eligibility.

pool of potential kin helpers is limited to two children—an unmarried daughter and an unmarried son. The mother's need is indexed in terms of the number of activities of daily living (ADL) for which care is needed. In this hypothetical two-child family, a child is likely to provide primary care at all but the most extreme level of disability. At that level of need, a paid helper is more likely to be the primary caregiver. Other unpaid helpers, such as more distant relatives and friends, have a relatively small probability of assuming such care responsibilities. Turning attention to the full array of helpers, however, it is clear that a diverse network is likely to be assembled by drawing on the resources of both the family and the marketplace.

Because the data for this analysis are cross sectional (the 1982 National Long-Term Care Survey) and wage rates could not be estimated for all potential family helpers, this specification is inadequate for testing complete theories of substitution. Nonetheless, the results suggest that future research will benefit from a network perspective rather than the more commonly used dyadic approach. It also highlights the importance of allowing for market substitutes at varying levels of intensities within the care network.

The supply of paid care alternatives has received scant research attention. Lacking direct estimates of the supply or market prices of paid care, analysts typically rely on proxies. Among those more commonly used are urban-rural or city size distinctions (Soldo, 1985; Hanley and Wiener, 1991; Kemper, 1992) and Medicaid eligibility of the care receiver (Soldo, 1985; Kemper, 1992). More importantly, models of community care arrangements typically do not condition outcomes on the supply of nursing home alternatives. Although there are numerous examples of equations predicting nursing home admission and others predicting type of community care arrangements, there are only a few instances in which even crude indicators of the supply of other care alternatives are incorporated (Sloan et al., 1992). Variations in the supply and price of nursing home care are a source of unmeasured heterogeneity in models of home care; variability in the supply of informal caregivers is confounded with other factors (such as marital status) in models predicting entry to a nursing home.

Even the most sophisticated cross-sectional models do not accommodate the diachronic nature of disability or compensating care. From the older person's perspective, the propensity to use different types of care arrangements is likely to change over the course of a disability or during the final years of life. During that time, changes also may occur in the level and type of care needed, as well as in the kin available to provide such care. Furthermore, the implicit price of care may change over the course of an illness. The out-of-pocket price of institutional care, for example, drops markedly if an older person spends down to Medicaid eligibility.

A longitudinal model of substitution has been proposed by Tennstedt and colleagues (1992), who define substitution as an increased number of days of formal community care and a decreased number of days of informal care at successive interview dates. These researchers also add a new dimension to studies of substitution by disaggregating help into six common care activities and exploring the possibility of substitution occurring only within specific tasks. As with most cross-sectional models, the price of formal and informal care, and the family's budget constraints are not measured. The major weakness of this approach, however, is the loss of information that ensues regarding the *extent* of substitution in terms of the total volume of care provided by different sectors.

More elaborate models of dynamic substitution have not been proposed, most likely due to existing data limitations. To model substitution over time requires information on the types of care received on a regular basis over the course of a chronic condition or illness. Such data are not available on a national basis.

Finally it is important to note that the supply of potential providers of care is itself dynamic. Exogenous change (e.g., death or migration of the primary caregiver) can initiate change in the size or structure of the care network. For the most part, prior research using panel data has allowed only for changes in the underlying structure of needs (Tennstedt et al., 1992). To date no published research has simultaneously modeled changes in the pool of potential providers and in the price or supply of paid providers along with changes in need. Limitations in currently available data preclude such an analysis (for reasons discussed below), but at the present time we also lack sufficiently developed theoretical frameworks to guide such analyses. Gerontologists, for example, have speculated about a "tolerance threshold" for informal care, but the nature of such an underlying process has not been given serious consideration in the context of shifts in the real and opportunity costs of parental care. A full account of the substitution of market resources for family resources awaits not only panel data merged with information on the supply and price of care alternatives but also considerably more developed theoretical formulations.

Substitution of Financial for Time Transfers

The framework shown in Table 6-2 also highlights the substitution of financial transfers for time transfers.[14] As discussed above, this type of substitution organizes the state's response to the care of frail elderly. Yet

[14] In this section we consider only those financial transfers from a family member to another relative. Structured intergenerational transfers, such as retirement benefits from Social Security, are not considered. Kingston et al. (1986) provide a macro-level perspective on structured intergenerational transfers.

considerably less is known about the extent to which the family commonly substitutes financial transfers for its collective time. In part, this situation results from limitations in data collection activities. Many national surveys fail to distinguish between services paid for out-of-pocket by the older consumer and those for which the family (regardless of residential status) pays (LaPlante et al., 1992). In other instances, high rates of item nonresponse have resulted when the frail elderly were asked to specify who pays for the care they receive (Liu et al., 1985). High-quality information on both direct (e.g., payment to the older parent) and indirect (e.g., payment to the provider on behalf of the parent) financial transfers from each potential provider needs to be combined with data on the care behaviors of all family members to complete an analysis of the ways in which the family as a whole substitutes financial transfers for its collective time. More finely grained analyses of substitutions within the family (in which one child provides time, for example, while another provides financial support) would require data on the transfer behaviors and relevant attributes of all potential donors within the family network.

Nonetheless, existing data suggest that about one-fifth of the elderly may receive either regular or episodic financial transfers from adult children (Soldo and Hill, in press; Stephen et al., 1992). Other data indicate that most of the costs of in-home personal care by paid helpers is borne out-of-pocket either by the elderly themselves or in combination with their families (Liu et al., 1985; Wiener and Hanley, 1992). The elderly and/or their families also absorb most of the costs of assistive technologies and housing modifications (LaPlante et al., 1992). In cross-section the income and asset profile of the most disabled elderly is markedly lower than that of healthier older persons (Hurd, 1991) suggesting that the frail elderly with large out-of-pocket health care costs may be drawing on the financial reserves of their extended families.

Although there has been little empirical analyses of the extent to which families substitute financial transfers for their time, there is considerable literature, primarily economic, concerned with the motivation for intergenerational financial transfers. Just as public policy concerns have motivated much of the research on the substitution of market care for family care, concern for the potential "crowding out" of private financial transfers by public benefits compels much of the economic research on the issue (Cox and Rank, 1992). Ultimately the redistributive outcomes of public transfers are influenced by the motivation of private donors for financial transfers.

With only a few notable exceptions discussed below, bequests rather than *inter vivos* transfers have been the focus of most empirical research on financial help from a parent to a child or from a child to a parent (Soldo and Hill, in press). The two primary economic models of transfer behavior are distinguished by the motive hypothesized. Theories of altruism postulate that children make financial transfers to their parents because they care about their well-being. No matter how the recipient disposes of the transfer, the donor's utility will be increased (Becker, 1981). But if state transfers are increased, altruism models also imply that there will be no net gain for the older parent because the state subsidies will simply replace dollar-for-dollar the transfers previously made by the family. Alternatively, exchange may motivate a child to make an *inter vivos* transfer. Services or financial transfers might be given, for example, in expectation of a bequest or a larger inheritance. Exchange-based accounts of *inter vivos* transfers predict that increased state subsidies will improve the well-being of the elderly because family transfers would not be reduced.

These theories, and variations on them, are useful for identifying the factors important to an adult in deciding whether to make transfers to his or her parent and, if so, its magnitude. In the selfish exchange model, for example, there are various qualities of the frail parent that a child wants to obtain in return for transfers given. The individual may want the parent to remain in a separate dwelling (and thereby protect the privacy of the child), to maintain independent functioning, or to avoid depleting the entire estate (spending down) in order to qualify for Medicaid.

In the tied transfers model the issues are similar, except that the transfers from the individual are designated for particular purposes. Service transfers or transfers of goods would allow the adult child more control over the beneficiary's behavior than would direct transfers of money. Purchasing services on behalf of the older parent is an ultimate form of restricted exchange. Alternatively, reciprocal exchanges could be a major motivating force in the decision to provide any transfers and the level of services to provide. The type of transfers from the parent to the child in the past would then affect the type of transfers the child chooses to give to the parent.

The empirical evidence concerning the various economic models is mixed and inconclusive.[15] To date there has been no empirical test of the substitution of financial transfers for time. Nonetheless, standard economic theory yields predictions of the sort that the higher the value of a child's time the more likely he or she is to make a financial rather than a time transfer. But various theories also point to other important considerations. Once a child

[15] The empirical evidence generally does not support the "wealth" implications of the altruism model; parents tend to equalize bequests rather than wealth across children (Behrman et al., 1990; Wilhelm, 1991). Support of both the altruism and the exchange models has been evidenced by monetary transfers received being positively related to donor's socioeconomic status (Cox, 1987; MacDonald, 1990); but Rosenzweig and Wolpin (1990) also describe a negative relationship.

decides to help a parent in some way, the form of the transfer would depend not only on the needs and wealth of the parent but also on the costs of inputs or preferences, the qualities or behaviors the child wants to encourage in the parent, the cost of market substitutes and the child's budget constraint, and finally, the type and volume of previous flows between the child and the parent.

The various hypotheses about motivation for transfers suggest a need for information to sort out whether past exchanges are important to future exchanges because they build expectations for reciprocity or because they reflect differences in orientation toward giving/receiving (heterogeneity that persists through the life course). Failure to control for unobserved permanent differences across households can lead to serious biases (Rosenzweig and Wolpin, 1990). The life-cycle timing of transfers also may be important; transfers given early in life, for example, may subsequently reduce assets (Kurz, 1984). The chronicity of need also may be important because individuals may resist receiving help if needs are transitory (Kurz, 1984).

CLOSING THE GAPS: FUTURE RESEARCH ON SUBSTITUTIONS

It has become commonplace for investigators of intergenerational transfers to argue that there are multiple currencies of exchange and alternative donors in any transfer currency. Nonetheless, a number of issues remain unaddressed. The simple conceptual framework of substitution discussed above highlights these gaps.

In part, data limitations preclude analyses of theories of substitution in currencies (e.g., time for financial transfers) or in providers (e.g., paid providers for family helpers). In other cases, the formidable methodological challenges of specifying a model of substitution have given rise to simplistic, and oftentimes misspecified, models. Both cross-sectional and projection models suffer from such oversimplifications. As a result, various gaps exist in our knowledge of current patterns, no less the future demand for alternative care arrangements. Until recently, virtually no data sets provided information sufficient to analyze transfers from which the elderly benefited. Nationally representative surveys that focused on the elderly and their health care needs rarely obtained information on the family structure of the respondent. The Supplement on Aging to the 1984 Health Interview Survey and its follow-up (the Longitudinal Survey of Aged), for example, provide detailed information on household members, but only count the number of sons and daughters living outside the household. Care providers are identified only generically (e.g., "a relative"), and information is not available on financial flows to the older respondent.

An early exception to this approach is the 1982-1984-1989 National

Long-Term Care Surveys. In this panel study of disabled elderly, demographic information (including marital status, education level, and employment status) is recorded for each child regardless of household residence. This data array enables researchers to specify the supply of potential informal caregivers in a micro-level analysis (see, for example, Wolf and Soldo, 1990). But because this survey does not provide the data needed for estimating the wage rates of all children, employment-related substitutions (i.e., time for money) cannot be explored fully. In addition, data are lacking regarding which children make regular financial transfers to parents. Such detailed information on both time and financial transfers is necessary to model the full family network of helpers and substitutions within it.

Data are currently being collected that will allow care and substitution issues to be addressed in more detail. The University of Michigan recently released the first wave of the Health and Retirement Survey (HRS) to the research community. This survey targets persons born between 1931 and 1941 (i.e., those aged 51 to 61 in 1992). More than half of these middle-aged respondents have one or more surviving parents. To provide the data necessary to analyze the extent to which parent care obligations effect the labor supply of those nearing retirement, the HRS collects limited data on the care needs of parents. For respondents with living parents, information also is collected on the siblings of the HRS respondent. Each sibling is identified in terms of demographic variables, as well as crude measures of wealth and attachment to the labor force.[16] Transfers, whether of time or money, to the parent of an HRS respondent are identified in terms of which adult child provides help and the intensity of the help provided. Parent and sibling data are collected for both spouses in a household, providing the opportunity to explore the extent to which two sets of family obligations compete for the resources of the middle-aged couple. An even more detailed listing of potential helpers and their transfer behaviors is incorporated into the new study of Asset and Health Dynamics (AHEAD), a national panel survey of persons aged 70 and older, also being fielded by the University of Michigan. Both HRS and AHEAD are supported by the National Institute on Aging.

Although a number of surveys will support the analyses of a broad range of substitution issues, all of them suffer from a common limitation— the absence of data on the price and supply of market substitutes for care. As noted above, only crude proxies are generally available. Confidentiality issues may be raised when survey data are linked with detailed area resource and pricing information, including Medicare, Medicaid, and private

[16] Complete information is available on all siblings only if the total number of siblings is less than five. Otherwise, such data are available only for a random sample ($N = 4$) of the sibship.

health insurance subsidies. Creative masking techniques are needed to close this final loop in the data needed to examine various aspects of substitution.

Understanding substitution of currencies or of providers depends, in part, on understanding the supply of resources available for accommodating disability in the older population. In this volume, Wolf discusses the demography of the family, including variations in family size, structure, and proximity. The supply of family resources is not adequately indexed in terms of the sheer number of different types of kin alive at various ages. Factors that reasonably constrain the time available for parent care, such as work and obligations to other kin, have proven difficult to measure in surveys in which the sole respondent is the potential beneficiary of the transfer. Even when crude measures of competing constraints are available they are difficult to model in cross section because these constraints and transfer behaviors are likely to be jointly determined. Thus, the tradeoff between parent care and work is poorly understood (Wolf and Soldo, in press).

Similarly, we know very little of how families allocate their resources of both time and money across the extended family, including parents, in-laws, adult children, and grandchildren. As four-generation families become increasingly common, (and, at the same time, more fragmented through divorce and remarriage), an important goal of research is understanding how such demographic changes will reconfigure the supply of potential helpers.

Additional research also is needed on how racial and ethnic differences affect both the supply of family resources and transfer behaviors. Fertility differentials suggest that the elderly in these subgroups have an abundance of potential helpers. Further research is needed, however, to determine the extent to which these seemingly large helper networks respond to the declining health of older parents. In large segments of minority populations, severe resource constraints operate, which would seem to favor family care over paid care in the community and time transfers over financial transfers. Alternatively, variations in kin bonds may discourage going outside the family network to secure personal care help, independent of the family's resource constraints.

Research also is lacking that evaluates the effects of family living arrangements on transfer and substitution behaviors. Coresidence anchors one end of the proximity spectrum and presumably those who live together are more inclined to pool their resources of both time and money so as to maximize the utility of all household members. But because coresidence also allows for economies of scale, the substitution of paid care for family care may be more feasible. At the same time the coresidence of a disabled parent with one child may encourage other children to provide financial support as well as less intensive care.

Considerable effort is needed to understand how state transfers that subsidize market care not only substitute for family care but also affect the price and supply of paid care services. The elderly's use of medical services clearly responds to shifts in consumer prices or provider subsidies (Morrisey, 1993). There is little evidence to date, however, on how the supply or price of home care services changes as the population ages and demand increases.

Finally, research is needed to understand not only the factors that promote various kinds of substitutions but also the consequences of these substitutions. How family and state transfers interact in terms of various outcomes has been largely neglected in previous research. Those studies that have examined such issues typically focus only on the risk of institutionalization (usually over a relatively short period of time) as the sole criterion of efficiency or efficacy of substitution. Yet other outcomes are reasonable to consider. Substitutions in either provider or currency may improve the overall well-being of the older beneficiary. The net effect of substituting paid care for some aspects of family care may be to redirect time transfers from the family to previously unattended areas of care. To the extent that paid care encourages the sustained work activity of potential providers, substitution also may protect contributions to structured intergenerational transfer programs financed through tax and payroll deductions (e.g., Social Security and Medicare trust funds).

Demographic research on substitution draws on many of the themes common to more traditional demographic research areas—family, resource allocation, labor economics, and dependency. Although some of the key issues have been explored with respect to child care dependencies (see, for example, Liebowitz et al., 1988), research on substitutions involving old age beneficiaries lags far behind.

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7

Medical Demography: Interaction of Disability Dynamics and Mortality

Kenneth G. Manton and Eric Stallard

As the elderly have become an ever-growing proportion of the American population, and as society has assumed some responsibility for their health, understanding the relationships among the factors that affect health has become crucial to policy makers. In this chapter we seek to build a framework for examining the interactions among the health-related behavior of individuals, genetic predispositions, the incidence of disease and fatality, the aging of the population, and levels of mortality and morbidity. Particularly crucial to policy makers is the relation between disability and mortality: When the incidence of disease or injury falls, so does the incidence of disability; and when death rates for people with a particular disability fall, that condition becomes more prevalent and thus demands on the health care system intensify.

To focus on the elderly demands a special approach because the mortality and health of the elderly and of younger people differ dramatically. The likelihood that someone suffers from multiple diseases, and from functional limitations, increases with age. Moreover, death in the old is due mostly to chronic diseases, with long histories. The models that apply to younger people, therefore, are not suitable for the analysis of the old.

Mortality is often studied with life tables estimated from vital statistics and census data. Life tables are useful for analysis of health policy and for social, epidemiological, and biomedical research. But they are deficient for refined analysis because they often lack information on the risks an individual faces. Everyone in a cohort—consisting, say, of all women, or of all people aged 45 to 64—is assumed to face the same risks as everyone else; thus, such studies cannot be used to analyze such things as the change in the health of given individuals, nor are they useful for assessing the efficacy and cost of interventions.

Medical demography, the study of chronic disease, disability, and mortality in mature and aging populations, has roots in actuarial and biometric models of mortality and insurance of health-contingent events (Spiegelman, 1968). The tradition includes Graunt's "bills of mortality" (1662), Bernoulli's life-table models of smallpox vaccination (1760), and the models of adult mortality devised by Gompertz (1825), Makeham (1867), Perks (1932), and Beard (1963a,b). Other well known examples include Clarke's use of "bioactuarial" models to isolate mortality associated with old age from mortality from exogenous causes (1950), and Bourgeois-Pichat's (1952, 1978) and others attempts to estimate the biological "limits" to life expectancy.

But medical demography lost impetus as research into the epidemiology of chronic disease specialized. That work, however, had its limitations in its reliance on case-control studies or studies of occupational cohorts and on longitudinal studies of selected populations from which it was difficult to estimate national rates of health events.

Recently, medical demography regained impetus for several reasons. First, concern has arisen because federal forecasts of mortality and population growth show biases with important implications for Social Security, Medicare, and other federal programs. The Social Security "crisis" of 1982-1983 showed that the population aged 65 and older was consistently underestimated, a bias that may still exist (Myers et al., 1987; Preston, 1993). Second, forecasts of the effects of disease on populations and of the health- and cost-effectiveness of interventions were often inaccurate (Walker, 1982; Frank et al., 1992). Third, the need to assess health trends and to characterize the natural history of chronic disease in the very old—those 85 or older— has intensified as life expectancy has lengthened and as that group has grown. Finally, longitudinal surveys of changes in the health of elderly Americans became available that were linked to Medicare data whose age reporting was better than that in decennial censuses (for example, the 1982, 1984, and 1989 National Long-Term Care Surveys, NLTCS).

Medical demography requires biomedically detailed models of the relation of age to health, to change in the ability to function, and to mortality in individuals. Biologically naive models do not accurately anticipate change in health or in the population health burden or the effects of intervention (Evens et al., 1992; Frank et al., 1992; Selikoff 1981; Tsevat et al., 1991). This is especially the case for the very old because of the special nature of the health processes of this group: they experience comorbidity—combinations of problems —impairment of function, a decrease in the ability to maintain biological stability with emergent nonlinearities in the change of population health parameters. Such complex processes are often modeled using parameters estimated from multiple data sets, each with specific sets of biological measures.

Medical demography is crucial in research about aging populations and in analyses of policies affecting them because mortality and health are dramatically different among the elderly than they are among younger people. Thus, demographic models, developed initially for younger populations, must be modified to describe and forecast health changes at late ages. For example, mortality in the old is due mostly to chronic diseases with long natural histories. Furthermore, the likelihood that a person has multiple concurrent diseases, and functional limitations, increases with age. Standard life tables are not designed to model such processes; for one thing, cause-elimination life tables assume that diseases operate independently—an assumption that may better approximate the effects infectious diseases have on the mortality of younger people. To model processes that become more complex with age also requires data that are not available from the usual demographic sources—for example, combinations of data on mortality from vital statistics with data on health from longitudinal health surveys.

The need for medical-demographic analyses to describe health changes in the old has two aspects. First, to describe the effects of preventative and other public health interventions we need models that can both identify relevant inputs—say, risk factors for chronic diseases and the provision of health services—and accurately predict the influence of those inputs on health. Second, anticipating health and functional changes calls both for measures to describe the special health problems of the elderly noted above and for models to anticipate how observed health factors translate into future changes. For chronic diseases in the elderly these requirements entail a long time horizon because the latency of chronic disease ranges, for example, from 7 years for premenopausal breast cancer to 50 years for asbestos-determined lung cancer. Thus, one must recognize that the health of the elderly is subject both to biological inertia and to changes brought about by ongoing interventions, such as the National Cholesterol Education Program (Johnson et al., 1993; Sempos et al., 1993). Recognition of these factors will affect both models of health changes in elderly populations and models of their needs for services.

We explore these issues in the four sections of this chapter. First, we review methodological issues in modeling chronic disease processes such as the nature of hazard functions for chronic disease, the effects of time-varying covariates on health processes, cohort effects, and the mathematical relation of health changes in individuals and in aggregate populations. Second, we examine processes for individuals, relating the interactions of the natural history of a chronic disease with life stage. Doing so is necessary to make the models biologically realistic so that they can accurately predict the effects of interventions. Third, we discuss the relation of disability and mortality; the measurement of disability in elderly persons; and the effects on measurement of using duration-based indicators of disability such as "active life expectancy." This discussion highlights the complexity of the health and functional status of elderly persons which requires assessments of multiple dimensions of function and the effects of comorbidity. Finally, we examine the role of genetics in shaping health in old age, which is different from its role at earlier ages because most lethal genetic defects are expressed by middle age. In elderly populations, health effects are polygenically determined and interact with environmental factors. Throughout, we discuss the use of primary data in estimation and of secondary data in determining model structure, because seldom will a single data set have the information necessary to estimate all relevant parameters for models of chronic disease and functional loss. This presentation assumes the reader has been exposed to the use of life tables, survival functions, hazard models, and common matrix and vector notation used in regression analysis.

COHORT ANALYSIS AND TIME-VARYING COVARIATES

The concepts of age, period, and cohort are basic in assessing the effect chronic disease has on the population. But they need careful definition to avoid the confounding that arises because cohorts are the interaction of age and period. We present, therefore, two definitions of a cohort. One is a "set" of persons who were all born in a particular year and thus are all the same age at any given point in time. Here the dynamics are demographic turnover—for example, passing age 65 or death. This is the standard concept of a cohort and is often used in gerontological and demographic research, though this work is hampered by the methodological problem of identifying age, period, and cohort parameters from aggregate data (see Schaie, 1983; Mason et al., 1981; and Hastings and Berry, 1979).

The second concept groups individuals, whatever their age, according to their exposure to a common experience at a specific time or place. A cohort might consist of the group of individuals who received a polio vaccination. This concept uses longitudinal microdata to estimate the parameters of a multidimensional, stochastic process that describes developments in the health of individuals. Mechanisms that are functions of the time lived represent aging. Period effects are exogenously generated perturbations, localized in time. Exogenous factors that permanently alter individual parameters are cohort effects. Thus, age, period, and cohort are identified with the temporal dependence of the parameters of processes of change in individual health. The designation of parameters to decompose the temporally changing correlations of multiple health variables permits the identification of the effects of age, period, and cohort (Feskens et al., 1991, 1992).

One cannot identify aggregate parameters for these factors using the variation of a single dependent measure—I.Q., for example—because within-cell variation is assumed to be "error." By relating age, period, and cohort parameters to individual health changes, one can construct a state-space model in which "state" is the individual's state of health measured by certain variables at a point in time and "error" is uncertainty about an individual's state. The variation in one individual's state from another's, or in his own over time, identifies the effects of cohort, age, and period.

These issues are illustrated by the individual failure process implicit in hazard models and explicit in state-space models. In a hazard model, the dependent variable is time to death for individual i (t_i). In Figure 7-1, A, B, C, and D are hazards describing changes in the distribution of t_i as fixed covariates are added. One could stratify the hazard on age, then period, and then cohort. As more covariates are added, the hazard approaches that for an individual—the "ultimate" stratification, described by curve D, that is, a "spike," or infinite hazard, at t_i. As a consequence of adding covariates, the shape parameter, which controls the hazard's curvature with time, increases. When t_i is known, the hazard is zero up to t_i, and then it is infinite. The distribution function of t_i, identical for everyone, is a distribution of the effects of unobserved variables over time. The individual's failure process is uninformative in these models (that is, mortality rates go from 0.0 to ∞ instantaneously). The probability that, *prospectively,* t_i can be determined *exactly* is vanishingly small; such models are not valid for predicting change.

Conditions for curve D occur frequently, as in aggregate data when the model is "saturated"—that is the number of data cells showing age by period effects and the number of parameters are the same—or when a hazard, estimated by maximum likelihood from t_i's, degenerates into spikes when too many parameters are estimated. This situation can develop unexpectedly if t_i is reported, not as a truly continuous variable, but grouped in temporal categories. Such "clumping" was found in data on unemployment duration when labor force reentry clustered at 13, 26, 39, 52 weeks, and so on, when unemployment benefits ran out (Heckman and Singer, 1984a,b). If not "adjusted" by, say, using dummy variables to filter out quarterly effects, the estimation of additional parameters caused the likelihood value to go to infinity. Problems also appear if the hazard rates change too rapidly, for example, declines in infant mortality in the first week, or month, of life may be so rapid that the actual information, and thus the degrees of freedom, is more limited than the sample size suggests (Potthoff et al., 1992). Both problems involve misspecification of the hazard function (Manton et al., 1992).

If continuous hazard functions with specific parameters are to be used to analyze health events, they must be substantively rationalized. The Weibull hazard function assumes that an event emerges after an *individual* takes *m* "hits."[1] In carcinogenesis, hits are mutations in the genes in a cell controlling its growth and function. If, as for colon cancer, the number of mutations is known, then the shape parameter value, or possibly its range is known (Ashley, 1969; Fearon and Vogelstein, 1990). Using biological data to establish the shape parameter prevents hazard from going to infinity. Without ancillary data to fix the value (or range) of the shape parameter,

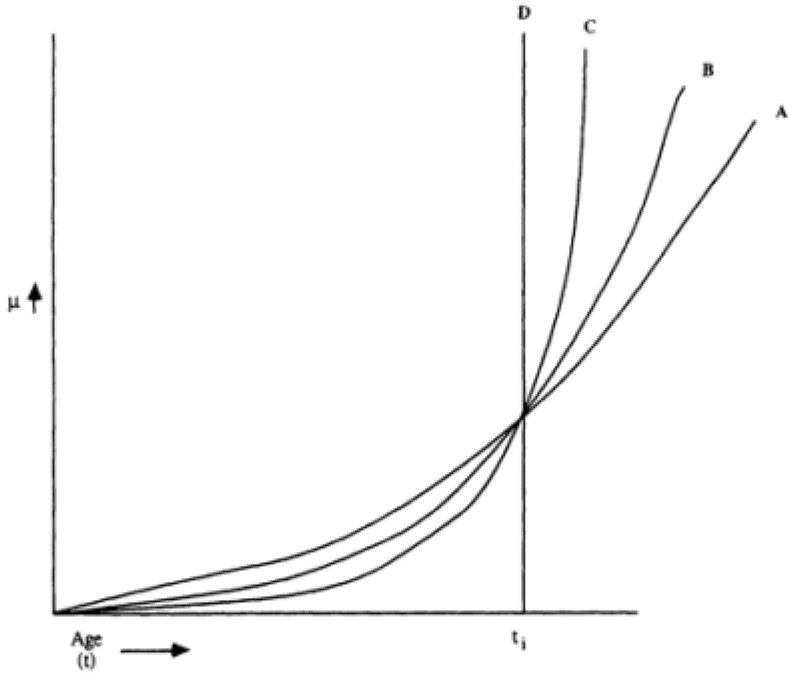


Figure 7-1
Illustrative hazard function for aggregate data. The hazard function $\mu(t)$ is the mortality rate for the infinitesimal interval $(t, t+\Delta t)$. Hence, $\mu(t)$At is the probability of death between t and $t+\Delta t$ for persons alive at t. The survival function $S(t)$ is obtained from

$$S(t) = \exp\left(-\int_0^t \mu(\tau)d\tau\right)$$

The distribution function F(t), obtained from $F(t) = 1 - S(t)$, is the probability that death occurs at or before age t.

[1] The Weibull distribution can be described by the formula $\mu(t) = bt^{m-1}$; where $\mu(t)$ is the age-specific mortality rate; b is a scale parameter; t is age; and m is the shape parameter.

the hazard may become infinite. Thus, using a hazard model without a theoretical rationale relies on chance to avoid parametric saturation and a degenerate likelihood (Trussell et al., 1992).

To biologically justify a hazard function requires specification of a mathematical relation between the failure process for an individual and the distribution of times to death in a population. Using a Weibull, the times to tumor onset in a population have the same distribution as the time for the first cell, in an organ's population of cells, to acquire *m* errors. Functions with these special mathematical properties generate extreme-value distributions (for example, the Weibull and Gompertz; see Mann et al., 1974).

A hazard can be generalized by assuming that each person has his own scale parameter, (see, for example, the work of Vaupel et al. (1979) on modelling frailty). Then, no matter how a population is stratified, $t_i$has irreducible variance. "Mixed" hazards use the marginal distribution of risk factors estimated from national surveys to identify fixed, and random, heterogeneity effects on mortality (Manton et al., 1993a). Slower age increases of the population hazard, assuming the individual hazard is a Weibull (cancer) or a Gompertz (total mortality), are produced both by the scale parameter being distributed over individuals (Manton et al., 1986), and by relating individual risks to a distribution of marginal risk factors. If the hazard is a convex function of risk factors, then the age trajectories of population and individual hazards are related by Jensen's inequality—E(μ($\mathbf{x}_{ir}$)) • μ(E($\mathbf{x}_{ir}$))—the average risk in a heterogeneous population (risk factors are represented by the vector $\mathbf{x}_{ir}$) is greater than (or equal to) the risk at the means of the risk factors E ($\mathbf{x}_{ir}$). Because survivors have more favorable values of $\mathbf{x}_{ir}$s, heterogeneity, *regardless* of its distribution, acts to decreas*e* population risk with time.

A hazard function implicitly has a parameter space with two dimensions, persons and time. In the extreme, there is *either* a time-*dependent* hazard with no individual heterogeneity, or a time-*constant* hazard *with* individual heterogeneity. To identify parameters, information on either individual failure, or risk differences, is needed. The correlation of parameters provides information on the relation of scale and shape parameters of the Gompertz (or other hazard) across populations or over species (Finch, 1990). In a stochastic process, risk-factors are *time* varying.

Macrolevel Models

Long time series of mortality—for, say, cancer deaths in the United States from 1950 on—can be used to model how vulnerable to specific diseases given cohorts have been. Trends in the causes of death must be distinguished from changes in the causes noted on death certificates; one example of the latter changes is the shift during the 1980s from listing emphysema, bronchitis, and asthma to listing "chronic obstructive pulmonary disease." If conclusions made from these data are to be meaningful, the hazards must be carefully defined.

Mortality data are often used to complement biologically detailed models of health events in select, longitudinally followed populations because few longitudinal data sets are large enough to precisely estimate cohort trends for specific diseases to late ages. Carey et al. (1992) showed that distinguishing between mortality patterns at late ages requires a sample of 100,000 or more. Few longitudinal studies meet this requirement. Conversely, mortality data are insufficient to study survival at late ages when age reporting error may significantly affect the distribution of times of age at death (Kestenbaum, 1992).

The failure process for "mixed" hazards can be described by a "compartment model," that is, a discrete-state, *continuous*-time, stochastic process in which transitions to unobserved health states are estimated using biologically plausible functions to infer prior health changes from the age distribution of mortality. Compartment models were developed to assess multistate drug metabolism (Jacquez, 1972) and biological experiments (Matis and Wehrly, 1979). They can also be applied to cohort data to study a population's health "metabolism"—the rate at which persons move through specific, but unobserved, health states. For example, to evaluate the utility of mammography, cohort mortality from breast cancer for American women from 1950 to 1988 was modeled as a mix of early, premenopausal, disease and late, postmenopausal, disease: The characteristics of the former are that it is histologically aggressive, that it involves a strong family history, that it is estrogen receptor negative, and that is has a short latency, of 7 years. The characteristics of the latter are that it is fertility sensitive, that it involves a weak family history of the disease, that it is less histologically aggressive, that it is estrogen receptor positive, and that is has a longer latency, 14 years. Data on cohort mortality were combined with data from the National Cancer Institute's Surveillance of Epidemiological and End Results (SEER) program to estimate stage-specific survival rates in order to simulate the efficacy of different age and time schedules for mammographic screening; the measure of efficacy was changes in the proportion of females identified with Stage I disease. By distinguishing early and late disease, with different latencies and age-incidence patterns, different screening schedules were evaluated (Manton and Stallard, 1992a). Second, data on the mortality from lung cancer of cohorts of American men from 1950 to 1988 were linked to data from the National Health Interview Survey (NHIS) on smoking (Harris, 1983). Using the marginal cohort distribution of cigarette consumption, cohort-specific relative risks for smokers and the rate at which persons quit smoking were estimated (Manton et al., 1993a). Third, cohort mortality rates for lung cancer, and for all other causes, were estimated simultaneously (Manton et al., 1993b). Fourth, U.S. mortality data organized by cohort were combined with (1) Weibull functions estimated from the incidence of mesothelioma (a type of lung cancer; Peto et al., 1982); (2), SEER-recorded incidence rates for mesothelioma (1975 to 1989); and (3) reported starts of asbestos exposure arranged in age by date matrices. The lack of detailed data on asbestos exposure necessitated the use of multiple data sources. Early exposures, in "insulation work equivalents" (assuming a linear dose response) were estimated using Weibull functions for specific cohorts to relate 15 years of mesothelioma incidence to reported "age by date" first responses. This assumes the validity of the multihit (Weibull) model of carcinogenesis for mesothelioma (Armitage and Doll, 1961). The use of time since first exposure, rather than age, in the Weibull, assumes that mesothelioma is due only to asbestos, and that other causes of death are elevated for persons with asbestos exposure (due to nonasbestos toxic work exposures). A table of estimated age by date of first exposure is used to forecast other asbestos-related diseases.

Thus, in these examples, combining data sources permitted analyses of specific diseases—though with limitations. Maximum likelihood procedures may not be optimal here because large samples may require smoothing parameter estimates for young and old cohorts with truncated mortality distributions (Manton and Stallard, 1992b). This is because sampling error is small relative to measurement error, and biases, such as right censoring of mortality and age changes in disease mechanisms, may dominate the variation of parameter estimates across cohorts. Second, a model's validity is based on its biological rationale. If there is no biological rationale to constrain model choice, a model fitting the data can always be found because of the inability to identify hazard functions in mortality data (Manton et al., 1994a).

Using clinical and experimental information to specify a model, and assessing it with cohort mortality data, depends on Bayesian principles because parameters are estimated conditionally on ancillary data. This approach differs from meta-analysis, which assesses the consistency of parameters across studies (Thompson and Pocock, 1991). A compartment model is tested against external data, say, cohort mortality rates from specific causes. Compartment models are exclusive: only the "best" studies are used in model development. Meta-analyses use all studies meeting specific criteria, which must be carefully examined to ensure that the selection is not biased. For example, "successful trials" are more likely to be published, and thus overrepresented in the literature, than are trials with negative results. Thus, the studies available in the literature may disproportionately represent certain outcomes. Second, the criteria used to select published studies influence the outcomes of meta-analysis. For example, meta-analysis was used to examine the relation of cholesterol to adverse health effects.

No study has yet shown a significant decline in *total* mortality produced by reducing serum cholesterol using drug therapy, though positive outcomes are shown for circulatory disease. Ravnskov (1992) argued that meta-analyses of cholesterol health effects are biased "samples" of studies.

Microlevel Models

Complementing mortality models are analyses of longitudinal microdata, in which the individual is modeled as a complex *system* whose evolution is governed by time-dependent processes operating at different levels of biological organization. In this view, aging is the loss of system integration—that is, increased entropy—and of homeostatic control of multiple linked processes (Firth, 1991; Goldberg et al., 1992). This type of model contains two types of jointly dependent processes. First, systems of autoregressive equations describe linked changes in J state variables, that is, x_{ijt}, (or the vector $\underset{\sim}{x}_{it}$), where j = 1, 2, ..., J and i indexes individuals,

$$\begin{aligned}\underset{\sim}{x}_{it+1} &= \underset{\sim}{u}_{0i} + \underset{\sim}{\alpha}_1 \ \mathrm{Age}_{it} + \underset{\sim}{\alpha}_2 \underset{\sim}{x}_{it} + \underset{\sim}{\alpha}_3[\mathrm{Age}_{it} \cdot \underset{\sim}{x}_{it}] + \underset{\sim}{\alpha}_4 \underset{\sim}{y}_{it} + \underset{\sim}{\alpha}_5 \cdot \underset{\sim}{Y}_{it} \cdot \underset{\sim}{x}_{it} \\ &\quad + \underset{\sim}{\alpha}_6 \cdot \underset{\sim}{Y}_{it}[\mathrm{Age}_{it} \cdot \underset{\sim}{x}_{it}] + \underset{\sim}{\alpha}_7[\mathrm{Age}_{it} \cdot \underset{\sim}{y}_{it}] + \underset{\sim}{e}^{d}_{it} \cdot \end{aligned} \tag{1}$$

Age_{it} denotes the age of person i at t, $\underset{\sim}{e}_{it}$ are stochastic shocks, $\underset{\sim}{y}_{it}$ are exogenous variables, and $\underset{\sim}{Y}_{it}$ is a matrix formed from the $\underset{\sim}{y}_{it}$. The J trajectories described by (1) represent both fixed and stochastic effects. Fixed effects due either to genetics or to exposures to a risk prior to the study are represented by constants, (for example, $\underset{\sim}{u}_{0i}$) or age changes (that is, $\underset{\sim}{\alpha}_1$) of $\underset{\sim}{x}_{it}$. The expression $\underset{\sim}{\alpha}_1 \cdot \mathrm{Age}_{it}$ may describe genetic age changes; for example, the age rate of loss of hepatic low-density lipoprotein receptors. These changes can be sex specific (Hazzard, 1990). Estimating an individual constant, $\underset{\sim}{u}_{0it}$, (or parameters of its distribution) requires multiple measures on each i, or assumptions about the distribution of $\underset{\sim}{u}_{0it}$ (or $\underset{\sim}{\alpha}_{1i}$) over persons. Parameters might be estimated from longitudinal data on identical twins. Genetic disease may manifest itself early in a person's life; that is, the stronger the effect of a gene on disease, the higher the rate of early death (Beregi et al., 1991; Marriotti et al., 1992; Takata et al., 1987; Thieszen et al., 1990). For example, the risk of genetic dyslipidemic hypertension is manifest by age 40 and declines with age (Reed et al., 1991). Strong selection can generate a rapid rise in mortality in "mid" age (e.g., age 30-80), with mortality approaching a constant at late ages (Perks, 1932; Thatcher, 1992). Such age patterns, found by Carey et al. (1992) and Curtsinger et al. (1992) in insect models, are manifest in human populations for specific diseases, such as breast and lung cancer, and possibly for total mortality (Lew and Garfinkel, 1990).

The term $\underline{\alpha}_3$ [$Age_{it} \times \underline{x}_{it}$] represents the alteration by risk factors of the age expression of genotype. For example, testosterone reduces hepatic LDL receptors and stimulates abdominal fat cells, which are more insulin resistant than are other fat cells (McKeigue et al., 1991). Insulin resistance may raise cholesterol and stimulate hyperinsulemia (Modan et al., 1991). The increase may be mitigated by the value (and age trajectory) of other variables, the body mass index (BMI) or the hematocrit.[2] Differences in age trajectories of hematocrit may maintain sex differences in mortality at late ages (Heikinheimo et al., 1985; Sullivan, 1991).

The term $\underline{Y}_{it}$ represents sets of K exogenous factors, $\underline{y}_{itk}$, $k = 1,...,K$. If K= 1, $\underline{Y}_{it}$ is a scalar: $\underline{Y}_{it} = \underline{y}_{it}$. If $K > 1$, $\underline{Y}_{it}$ is a vertical "stack" of K, JxJ diagonal matrices, where the J diagonal elements of the k^{th} matrix are $\underline{y}_{itk}$. To conform with $\underline{Y}_{it}$, α_5 and α_6 have J rows and JxK columns so the products $\alpha_5 \times \underline{Y}_{it}$ and $\times$ $\underline{Y}_{it}$ are JxJ. The term $\alpha_5 \times \underline{Y}_{it} \times \underline{x}_{it}$ is the interaction of exogenous factors with state variables; $\alpha_6 \times \underline{Y}_{it}$ [$Age_{it} \times \underline{x}_{it}$] is the interaction of exogenous factors with age changes in state variables. If there is a "normal" trajectory of cholesterol metabolism, and it is affected by other characteristics, then $\underline{y}_{it}$ might reflect pharmaceutical control, that is, a drug's effect may be modulated by, say, BMI and age changes in lipid metabolism (Knapp et al., 1992). These interactions determine whether interventions affect mortality at late ages. Clinical studies suggest that some risk factors are significant to late ages; (in one example, treatment of isolated systolic hypertension reduced the risk of stroke; SHEP Cooperative Research Group, 1991).

The terms in equation (1) involving $\underline{\bar{x}}_{it}$ reflect the effect of prior states on future states, $\underline{x}_{i,t+1}$, that is, state dynamics. Diffusion (e^{d}_{it}, where d is an age-dependent scale parameter) prevents t_i from being "known." Unobserved stochastic processes, $\underline{z}_{it}$,also influence $\underline{x}_{it}$. Inversely, temporal changes in $\underline{x}_{it}$ covariances may be used to infer the characteristics of $\underline{z}_{it}$, especially if $\underline{x}_{it}$ are measured often. The variables $\underline{z}_{it}$ may be manifest as high-order lags in equation (1) (Manton et al., 1993c). Lags may be described by integrating exposures to risk factors over time, for example, the number of years smoked multiplied by the average number of packs of cigarettes smoked— the "pack years"—reflects cumulative "damage."

The second type of process is described by a mortality function,

$$\mu(\underline{x}_{it}, \text{Age}_{it}) = \sum_{m=1}^{M} \mu_m(\underline{x}_{it}, \text{Age}_{it}) = \left[\mu_0 + \underline{x}_{it}^T \underline{\beta} + \frac{1}{2}\underline{x}_{it}^T \underline{B}\, \underline{x}_{it}\right] e^{\theta \text{Age}_{it}} . \quad (2)$$

[2] The body mass index (BMI) is the ratio of weight in kilograms to height in meters; hematocrit levels may affect atherogenesis by promoting LDL oxidation (McCord, 1991).

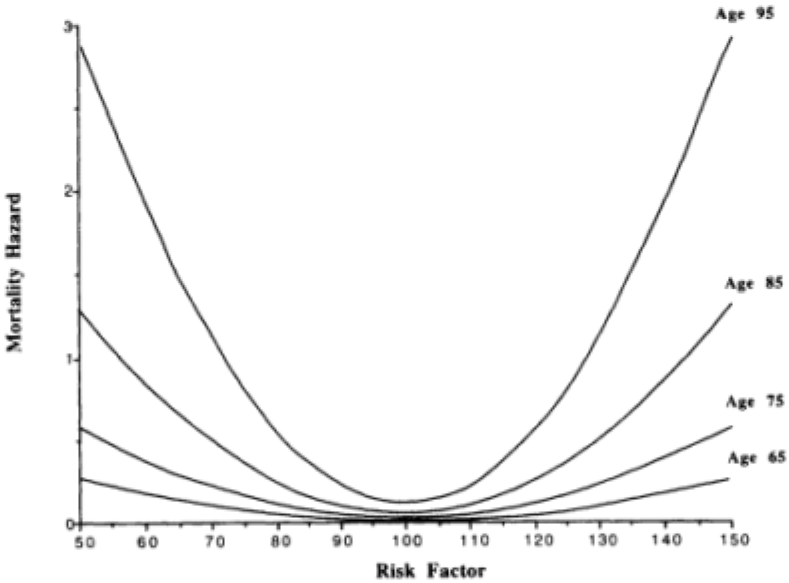


Figure 7-2
Univariate quadratic hazard function for a single risk factor (x), for a fixed value $\theta = 0.0805$, but at different ages. The quadratic hazard is drawn with the following parameter settings: $\mu(x) = (0.01+[(x-x^*)/100]^2)\exp[0.0805(\text{Age}-65)]$, and $x^* = 100$.

Equation (2) is a "Gompertz" with the scale parameter replaced by a quadratic function of the realizations, $\underset{\sim}{x}_{it}$, of the stochastic process in equation (1). In other words, equation (2) is dependent on time-varying covariates. The quadratic can be decomposed into terms for each of M diseases to allow risk factors to relate differently to different diseases (i.e., the $\underset{\sim}{B}_m$'s can be different). If θ represents the effects of unobserved age-related variables ($\underset{\sim}{z}_{it}$) on mortality, senescence can be explicated by improving the measurements of the state variables $\underset{\sim}{x}_{it}$. Alternatively, a cause may have its own θ_m due to unobserved variable effects specific to *m.* θ declines in value as more of the age dependence due to senescence measured by θ is assignable to state variables ($\underset{\sim}{x}_{it}$ become more informative).

A quadratic function is used for several reasons. A U- or J-shaped function describes the relation of mortality to many risk factors (Jacobs et al., 1992; Neaton et al., 1992). The curvature of the quadratic is a function of θ, so the rate of change of risk factor effects on mortality that is related to age reflects interactions with unobserved variables, $\underset{\sim}{z}_{it}$. The function with $\theta = 0.0805$ is shown for select ages in Figure 7-2. The horizontal axis represents x; $x°$is a value producing the *lowest* mortality; for example, $\mu(x°) = .01$ at age 65. The vertical axis is the mortality level. As age increases from 65-95, with θ and $\underset{\sim}{x}_{it}$ fixed, mortality increases.

Changes in θ are illustrated in Table 7-1 for the 34-year follow-up of 10 risk factors from the Framingham Study: 7 dimensions identified from 27 functional and physical performance items for the 1982-1984 NLTCS and mortality for 1982-1986; and 7 dimensions from the 1982-1984-1989 NLTCS and mortality for 1982-1991. For Framingham, risk factors reduce the male θ form 9.4 percent to 8.1 percent, a relative decline of 14 percent. For females, the relative decline in θ is 19 percent, from 10.0 to 8.1 percent. The relative decline of θ using 1982-1984 NLTCS functional scores is 51 to 61 percent. Thus, functional scores described the age dependence of death better than risk factors (Campbell et al., 1985; Dontas et al., 1991; Grand et al., 1990). This finding is consistent with decreased physical activity being a major risk factor at late ages: 56 percent of deaths in a population whose mean age was 84.5 years were due to pulmonary embolism, congestive heart failure, or pneumonia—all diseases associated with reduced activity (Gross et al., 1988). Conditioning θ on functional status, suggests that mortality rises 3.6 to 4.0 percent per year of age (thus it doubles in 17-19 years) compared with a doubling of mortality in 6.9 years for a θ of 10 percent. Controlling income and education, as well as function, reduced θ to 2.6 percent. For the 1982-1984-1989 NLTCS, the relative decline in θ is smaller (35 to 48 percent) because, over the longer period 1984-1989, intermediate transitions cause information in the 1984 scores to decay.

A second measure of information is the proportion of ^{2} explained by $\underset{\sim}{x}_{it}$ (that is, test 2, with θ = 0.0). In the Framingham study, risk factors explain 70 percent of the ^{2} due to age in the mortality model. In the 1982-1984 NLTCS, 92-95 percent of the ^{2}due to age is explained. In the 1982-1989 NLTCS, function accounts for 79 percent and 87 percent (for males and females, respectively) of the ^{2} explained by age. The decline in the age variation of mortality explained by function for 1982-1989 data is smaller (14 and 7 percent for males and females) than the relative changes in θ, 24.1 and 23.3 percent. Thus, loss of the ability to explain the age dependence of mortality between 2- to 5-year intervals is moderate and similar to that for other types of survey error. θ adjusts for differences in the quantity and type of $\underset{\sim}{x}_{it}$ to better embed the estimated discrete-time process in the underlying continuous-time process, and thus reduces bias.

Other reasons for using a quadratic is that it describes homeostasis in an organism (that is, negative feedback keeps an individual's state within viable regions of $\underset{\sim}{x}_{it}$). The quadratic defines a point at which mortality is minimized:

$$\underset{\sim}{x}_t^0 = -\underset{\sim}{B}^{-1}(t)\,\underset{\sim}{\beta}(t) = -\underset{\sim}{B}^{-1}\,\underset{\sim}{\beta}\,. \qquad (3)$$

TABLE 7-1 Chi-Squared Values Associated with the State Variables, , and with the Senescence Process in Cause-Specific and Total Mortality Functions

Data Source, Test	Males		Females	
Number (n), and Description[a]	$^{2}_{n}$	$^{2}_{n}/^{2}_{1}$(%)	$^{2}_{n}$	$^{2}_{n}/^{2}_{1}$(%)
Framingham: 10 risk factors				
1. Full process	2,174.8	100.0	2,047.8	100.0
2. x_{it} alone, θ = 0	1,518.8	69.8	1,445.5	70.6
3. Effect of θ	656.0 (θ = 0.0805)	30.2	602.3 (θ = 0.0812)	29.4
4. θ alone, no x_{it}	1,350.4 (θ = 0.0939)	62.1	1,406.1 (θ = 0.1002)	68.7
1982-1984 NLTCS: 7 functional scores (based on 27 attributes)				
1. Full process	3,206.5	100.0	4,728.1	100.0
2. x_{it} alone, θ = 0	2,945.9	91.8	4,467.5	94.5
3. Effect of θ	260.6 (θ = 0.0401)	8.2	260.6 (θ = 0.0364)	5.5
4. θ alone, no x_{it}	1,163.6 (θ = 0.0811)	36.3	2,210.6 (θ = 0.0937)	46.8
1982-1984-1989 NLTCS: 7 functional scores (based on 27 attributes)				
1. Full process	4,837.9	100.0	7,493.8	100.0
2. x_{it} alone, θ = 0	3,821.5	78.9	6,550.5	87.4
3. Effect of θ	1,016.4 (θ = 0.0528)	21.1	943.3 (θ = 0.0475)	12.6
4. θ alone, no x_{it}	2,662.2 (θ = 0.0815)	55.0	4,466.0 (θ = 0.0910)	59.6

[a] For tests 1, 2, and 4, the baseline model for comparison assumes constant mortality for all ages and risk factor values.
Test 3 compares the models in tests 1 and 2.

SOURCE: Data are from the Framingham Heart Study and the 1982, 1984, and 1989 National Long-Term Care Surveys.

The second expression arises if Age_{it} is not in $\underset{\sim}{x}_t$, (for example, if age's effects are represented by θ), with the implication that $\underset{\sim}{x}_t^0$ is constant. If age is in $\underset{\sim}{x}_t$, $\underset{\sim}{x}_t^0$ is a linear function of age. It is also unlikely that a hazard with greater than second-order terms can be estimated in most data sets. The multivariate normal distribution of $\underset{\sim}{x}_{it}$, implied by a quadratic hazard, is the statistically most conservative estimator of a multivariate distribution with higher-order moments (>2) because it has the maximum entropy of any distribution with a fixed covariance matrix.

The interaction of a quadratic hazard and linear dynamics preserves properties of the $\underset{\sim}{x}_{it}$ distribution that other hazard functions do not. The quadratic mortality matrix $\underset{\sim}{B}(t) = \underset{\sim}{B}_1(t) + \ldots + \underset{\sim}{B}_M(t)$ reduces the variance-covariance matrix of $\underset{\sim}{x}_{it}$ in each measurement interval for each of *M* causes: it naturally parameterizes cause-specific mortality changes. The logistic only approximates a hazard (the dependent variable is the log of the odds ratio, *p*/(1-*p*), where p is the event probability). If one decomposes data by time, or cause of death, a logistic estimated for each interval, or cause, cannot be recomposed to generate a logistic for total time, or mortality, because the product of logistics is not logistic (Woodbury et al., 1981). Estimates from the Cox model (1972) are not consistent if cause-specific rates are not proportional over age; if, for example, exponential hazards are estimated for three causes, (say, cardiovascular disease (CVD), cancer, and other), the three functions produce a *sum* of exponentials so coefficients for total mortality cannot be compared with coefficients in cause-specific functions. The Cox model also assumes that the population is risk homogeneous and that competing risks are independent (Gill, 1992). Furthermore, in the quadratic the matrix of second-order partial derivatives of μ(·) is independent of $\underset{\sim}{x}_{it}$, that is,

$$\frac{\partial^2 \mu(\underset{\sim}{x}_{it}, \text{Age}_{it})}{\partial \underset{\sim}{x}_{it}\, \partial \underset{\sim}{x}_{it}^T} = \underset{\sim}{B}(t)\,. \tag{4}$$

Thus, interactions of risk factors are constant within age strata. Since the inverse of equation (4) appears in equation (3), all these interactions are represented in $\underset{\sim}{x}_t^0$. Introducing quadratic terms in a Cox model does not preserve these properties, for one thing, quadratic effects are scale dependent.

Estimation of equations (1) and (2) assumed that the likelihood for a longitudinal study can be factored conditionally on $\underset{\sim}{x}_{it}$. To integrate parameter estimates from (1) and (2) in life tables, difference equations are needed. Three describe mortality dynamics. Survival is

$$l_{t+1} = l_t \,|\, \underset{\sim}{I} + \underset{\sim}{V}_t \, \underset{\sim}{B}_t \,|^{-1/2} \exp\left\{ \frac{\mu_t(\bar{\underset{\sim}{x}}_t) + \mu_t(\bar{\underset{\sim}{x}}_t^*)}{2} - 2\mu_t\left(\frac{\bar{\underset{\sim}{x}}_t + \bar{\underset{\sim}{x}}_t^*}{2}\right)\right\} \quad (5)$$

where $\underset{\sim}{B} \circ \underset{\sim}{B}(t)$, $\underset{\sim}{B}_t \circ \underset{\sim}{B}(t)$, and $\mu_t(\underset{\sim}{x}) \circ \mu(\underset{\sim}{x}, t)$ are from (2), $\bar{\underset{\sim}{x}}_t$ are risk-factor means, and $\underset{\sim}{V}_t$ is the risk-factor covariance matrix at t. The vector of mortality-adjusted risk factor means is

$$\bar{\underset{\sim}{x}}_t^* = (\bar{\underset{\sim}{x}}_t - \underset{\sim}{V}_t^* \, \underset{\sim}{B}_t \, \bar{\underset{\sim}{x}}_t)\,. \quad (6)$$

Mortality-adjusted variances are

$$\underset{\sim}{V}_t^* = (\underset{\sim}{I} + \underset{\sim}{V}_t \, \underset{\sim}{B}_t)^{-1} \, \underset{\sim}{V}_t\,. \quad (7)$$

After adjusting for mortality, the $\bar{\underset{\sim}{x}}_t$ of survivors changes:

$$\bar{\underset{\sim}{x}}_{t+1} = \underset{\sim}{u}_0 + \underset{\sim}{A}_t \cdot \bar{\underset{\sim}{x}}_t\,. \quad (8)$$

where $\underset{\sim}{\mu}_0$ and $\underset{\sim}{A}_t$ are coefficients in (1). The covariance matrix adjusted for dynamics is

$$\underset{\sim}{V}_{t+1} = \underset{\sim}{\Sigma}_{t+1} + \underset{\sim}{A}_t \, \underset{\sim}{V}_t^* \, \underset{\sim}{A}_t^T\,. \quad (9)$$

where $\underset{\sim}{\Sigma}_{t+l}$ is the error covariance matrix at age t + 1. For functional scores, which sum to 1.0 and are nonnegative, diagonals of $\underset{\sim}{V}_{t+l}$ are bounded by Bernoulli variance requiring constraints in equation (9) and on $\underset{\sim}{A}_t$ in equation (1) (Manton et al., 1993c). Equations (5) through (9) are used in health forecasts and simulations.

To test the model, first, standard errors of coefficients in equations (1) and (2) are calculated. Second, trajectories of the $\bar{\underset{\sim}{x}}_t$ and $\underset{\sim}{V}_t$ are compared with external data. Examining these trajectories requires more data, and is more stringent, than evaluating a hazard's prediction of t_i. In Table 7-2, we illustrate the effects of state dynamics. The life tables used parameters estimated from the 25-year follow-up of the Finnish East-West study in equations (5)-(9) (Pekkanen et al., 1992). If life tables are calculated with both $\bar{\underset{\sim}{x}}_t$ fixed and $\underset{\sim}{V}_0$ =0.0, (assumption 1) there is a 32-33 percent upward bias in life expectancy. With only $\underset{\sim}{V}_0$ = 0.0 (assumption 2) the bias is 10-15 percent. The addition of time-varying covariates (assumption 3) reduces error to 0.4-0.6 percent.

The importance of time-varying covariates, and the effects of specific hazard functions on results, is now realized by epidemiologists. In Gordon et al. (1989), identification of the importance of HDL cholesterol in U.S., but not British, studies was traced to the use of different hazard models. Regression dilution is believed to have caused the effects of cholesterol on mortality to be underestimated (Cooper et al., 1992; Davis et al., 1990;

Jacobs et al., 1992), emphasizing the need for multiple measurements to better identify their true level.

TABLE 7-2 Life Expectancy at Age 40 Under Alternative Assumptions About Risk Factor Dynamics in 25-Year Follow-up of Finnish East-West Study

	Life Expectancy, e_{40} (years)		
Assumption	East Finland	West Finland	Description
	29.5	31.8	Life table
1	39.0 (+32.2%)	42.2 (+32.7%)	Risk estimated for baseline risk factor measurements
2	32.5 (+10.1%)	36.6 (+14.9%)	Risk estimated from risk factor means and variances/ covariances
3	29.6 (+0.4%)	32.0 (+0.6%)	Risk factor distribution changes according to regression estimates

SOURCE: Data from Pekkanen et al. (1992).

θ can be used to adjust $\underset{\sim}{\beta}$ for unobserved health differences between populations so that national mortality data that are unbiased, but uninformative about disease mechanisms, can be integrated with longitudinal select population data that may be biased for the national population being studied. Thus, the state-space model can reduce bias in integrating multiple survey and demographic data sources in cross-national studies (Dowd and Manton, 1990). Initial age- and sex-specific risk-factor conditions ($\underset{\sim}{\bar{x}}_0$ and $\underset{\sim}{V}_0$) can be estimated from cross-sectional survey data. From national vital statistics, the proportion of mortality for each of M causes can be determined. Because θ represents the average age-related effects of $\underset{\sim}{z}_{it}$, it reflects unmeasured differences between sources of population data just as it adjusts for unobserved variable effects when different risk factors, or measurement intervals, are used.

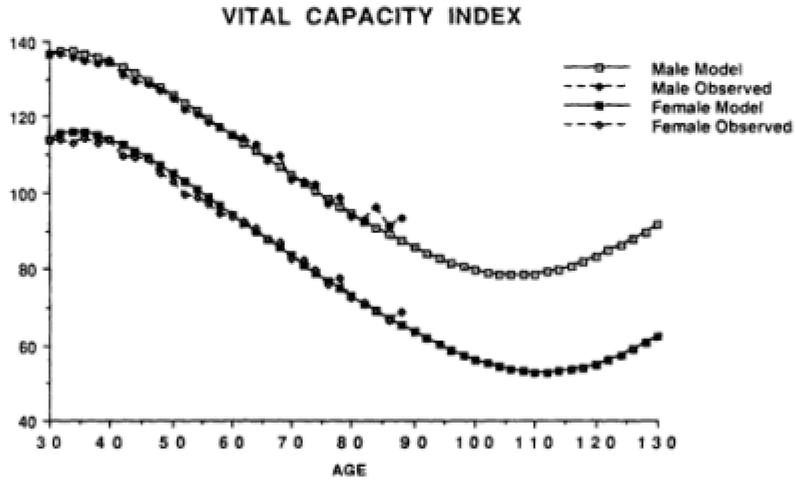
Dependent risks can be identified using time-varying state variables measured before death (Tsiatis, 1975). Assessment of dependence suggests that prevention can, by changing x_{ijt}, affect other risk factors and several causes of death and thus affect health more than would a treatment that reduces mortality from a specific cause. The dependence of diseases does not have a large effect until mortality risks are high enough to deplete the high-risk groups. Thus, dependence is important at late ages, when most deaths occur and the trajectory of mortality is uncertain. The existence of cause dependency and risk-factor interactions suggests that traditional cohort methods need strong assumptions to reconstruct mortality at late ages. Counts of deaths at late ages, by definition, are small and uncertain, and they reflect nonlinear state dynamics.

Although equation (1) is linear, its use in equations (5) through (9) can produce nonlinear effects, like sex-specific age changes of the means of hematocrit and the vital capacity index (VCI). In Figure 7-3a, the VCI means decline, as expected, until age 105. This pattern is due to the exponential increase of mortality with age which, by 95, is so large that risk-factor means for survivors ($\bar{x}_t$) must approach x_t^0. In Figure 7-3b, the hematocrit means for females remain lower, even postmenopausally, than male hematocrit means, which decline after reaching a peak (Sullivan, 1991).

Failure to understand risk-factor interactions and dynamics may be why prevention trials do not reduce mortality by the amount suggested in population studies. A logistic coefficient does not show how intervention changes other risk factors over time. In a state-space model, the dynamic equations describe how changes in risk factors interact over time. Indirect risk-factor effects may be positive or negative. Diuretic use in diabetics decreases blood pressure, but elevates cholesterol *and* blood glucose: *one* risk factor is reduced, but *several* increase. In postmenopausal women with osteoporosis and reduced estrogen, atherogenesis accelerates because increased cholesterol and calcium release into the blood, raises the calcification rate of arterial plaques (Moon et al., 1992). Treatment of osteoporosis with estrogens has beneficial effects on multiple risk factors and outcomes and may produce improvements *larger* than those measured in population studies (Stampfer et al., 1992).

Because of diffusion, the uncertainly of forecasts from state-space models is higher than is the uncertainty of forecasts from aggregate models. This difference can be represented in aggregate forecasts using empirical Bayes methods (see, for example, Manton et al., 1989). Uncertainty may be dealt with by imposing a utility function on the outcome distribution, discounting the costs of some and increasing costs of others. Confidence in a decision may increase when outcomes are weighted. For example, the answer to the question of whether shortfalls in Social Security trust funds are as important as, or more important than, excesses could reduce uncertainty about decisions on marginal tax rates.

Thus, to deal with cohort effects in medical demography, one needs both macrolevel compartment models represented by differential equations with parameters specified from biomedical data, or microlevel state-space models estimated from longitudinal data in which measurements of multiple risk factors are made. The procedures are complementary. Estimates from



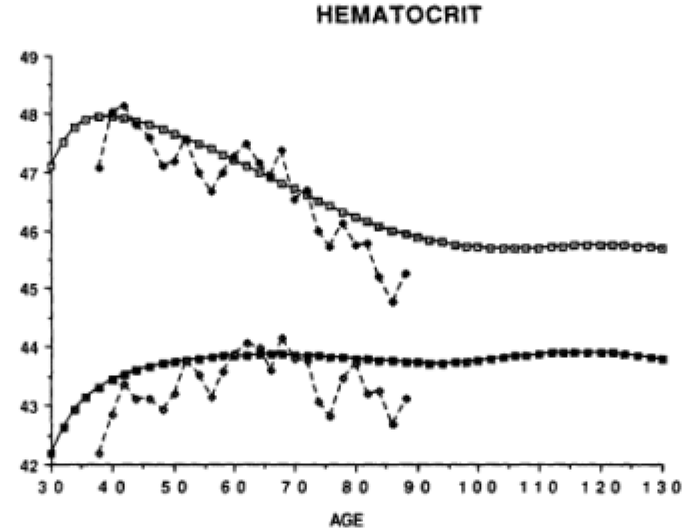


Figure 7-3
Variation in vital capacity index and hematocrit by age and sex.
SOURCE: Data are from the Framingham Heart Study.

the one may be used to help specify and estimate the parameters of the other.

DISEASE STAGES, NATURAL HISTORY, AND THE LIFE-CYCLE

Because chronic diseases take a long time to develop, they cannot be treated as events. They must be modeled as processes, with characteristic (and lengthy) natural histories whose evolution interacts with the characteristics of the person suffering from the disease. Representing these effects by the age dependence of mortality presents problems because changes in the age dependence may not be recognized for several reasons: reliance on standard hazards like the Gompertz, analyses of the logarithm of rates—a transformation that hides significant deviations, and the use of statistically inefficient estimators (like ordinary least squares). Despite improvements in the quality of data for late ages, reliance on *assumptions* about the age trajectory of mortality is common. (See, for example, National Center for Health Statistics, 1987; Lee and Carter, 1992). Human mortality at advanced ages often deviates from the Gompertz (Bayo and Faber, 1985; Kestenbaum, 1992; Thatcher, 1992).[3] Although human data are subject to age misreporting [4], that alone does not explain all deviations from a Gompertz. Making assumptions about the tail of the distribution of human ages at death is similar to designing experiments assuming that the Gompertz is valid, and making studies large enough to estimate Gompertz parameters but not large enough to test alternative models. Even if a Gompertz fits cohort data, it is not clear what to expect in cross-sectional data representing a changing mix of cohorts with different parameters (Manton et al., 1986).

Not all risks of chronic disease increase monotonically with age. Osteo-arthritis, for example, decreases after age 75 (Bagge et al., 1992); and if they survive to middle age, persons with familial high cholesterol appear to have normal survival. Furthermore, persons predisposed to a disease are selected out of the population or, if *not* selected out, have the disease controlled. As diseases are controlled, the age trajectory of mortality changes shape.

Medical demography is concerned not only with the lifetime distribution of health events, but also with their distribution within life stages, in

[3] Carey et al. (1992) and Curtsinger et al. (1992) show that the Gompertz did not describe mortality in large, controlled insect studies.

[4] In 1979, of 850 alleged centenarians traced in Great Britain, age was reported incorrectly for 2.5 percent (Thatcher, 1992).

which health is dominated by specific diseases. Disease models with differing time scales, and with more detail about the effects of age on mortality and risk-factor processes, are required to design interventions. Prevention or treatment may have larger effects if introduced *before* significant organ damage occurs (as they do in the case of osteoporosis, Overgaard et al., 1992), and renal function loss in diabetics (Chan et al., 1992). Diseases once limited to a certain life stage may become lifelong, with multiple recurrences, and require medical surveillance and intermittent treatment. Early-stage, premenopausal breast cancer, treated successfully, may recur 30 years later if the disease reflects immunological defects. Below we briefly review the characteristics of several chronic conditions or syndromes important in elderly populations.

Dementia

Diseases that are prevalent at late ages include Alzheimer's and related dementias. Alzheimer's has a long natural history, with death often due to comorbidity; in one study, 70 percent of deaths were due to pneumonia (Burns et al., 1990). Data from the Baltimore study of aging suggests that dementia cases, with good care, may live nearly normal life spans. Two difficulties in studying Alzheimer's disease are that its progression is indicated by slow changes on multiple cognitive dimensions and that it often coexists with other types of dementia.

Heart Disease

Heart disease progresses over time. Onset of the disease at early ages is often caused by genetic factors. Factors that affect heart disease between ages 30-50 may be quite different to those affecting the older population.[5] Treatment is effective early in a heart attack. Besides improving function, coronary bypass surgery in patients over age 80 did much better than medical treatment in increasing 3-year survival: the ratios were 77.4 percent and 55.2 percent, respectively (Ko et al., 1992). As procedures have improved, the benefits of surgery have increased (Muhlbaier et al., 1992). If persons survive early heart disease, they may later develop chronic health failure

[5] For example, disease that affects those from 30-50 years old may be due to cardiac vasospasm resulting from catecholamine stimulation, aggravated by nicotine and carboxyhemoglobin from smoking, and producing cardiac arrhythmias—especially with arterial damage due to hypertension (Golino et al., 1991; Gutstein, 1988; Yeung et al., 1991). Later, atherosclerosis in those aged 50-75 produces myocardial ischemia, causing infarction. Hemostatic factors may lower the age of infarction by accelerating the development of thromboses at the sites of atheromas not yet occluding an artery.

(CHF) and left ventricular hypertrophy (LVH) because of the interaction of reduced peripheral circulation, reduced cardiovascular efficiency, and hypertension (Kitzman and Edwards, 1990; Lakatta, 1985). The age-standardized U.S. hospitalization rate for CHF from 1973-1986 increased 60 percent (Ghali et al., 1990). Now both CHF and LVH are treatable using ACE-II inhibitors (SOLVD Investigators, 1991; Weber and Brilla, 1991).

The effect of cholesterol on CVD varies with age, especially for women (Jacobsen et al., 1992; Knapp et al., 1992). This variation may be due to a U-shaped relation of cholesterol to total mortality and to the fact that some premenopausal women have cholesterol low enough to raise other disease risks (see, for example, Neaton et al., 1992). Thus, when cholesterol rises postmenopausally for some women, risks could decline.[6]

Nutritionally Related Disorders: Systemic Factors

A newly appreciated aspect of chronic disease is the effect of nutrition on antenatal development. The data suggest that maternal malnutrition, which produces low birth and placental weight, affects the fetal development of multiple organs and that these effects become manifest above age 65 as chronic diseases (Barker, 1990; Barker and Martyn, 1992; Barker et al., 1989, 1991a,b, 1992a,b,c). Fetal physiology requires the brain to receive nutrition at the expense of other organs. The liver can be damaged, affecting fibrinogen and other hemostatic factors and increasing CVD risk (Barker et al., 1992a; Barker and Martyn, 1992). Lung and pancreatic function can be impaired, so that chronic lung disease and adult-onset diabetes mellitus appear.

The effects of antenatal nutrition on chronic disease may explain long-term changes in the risks of chronic disease. Despite literature suggesting that chronic diseases are consequences of industrialized society (Dubos, 1965; Omran, 1971), declines of some of those diseases started long before major prevention efforts. Antihypertensive therapy was first introduced in the 1950s, and a national program did not begin until 1972-1973. Yet, U.S. mortality from stroke declined after 1900—41.7 percent from 1900-1948, for example. An analysis of diagnostic practices and coding on death certificates suggests that declines were real by 1925 (Lanska and Mi, 1993).

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[6] Frank et al. (1992) found that reducing cholesterol below 200 milligrams per deciliter increased mortality for 60 percent of the population—a proportion varying by sex and by age: it was smaller at 30 and higher at 75. The relation of low cholesterol to mortality from several diseases (Frank et al., 1992; Jacobs et al., 1992; Neaton et al., 1992) may explain why cholesterol has little relation to CVD risks for woman at late ages and why their optimal values are higher (220 mg/dl) than those for men (177 mg/dl; Manton et al., 1993c).

Research by Fogel at the University of Chicago shows that chronic disease rates were higher for Civil War veterans aged 65 in 1910 than for veterans over age 65 in the 1985-1988 NHIS. The decline per decade in chronic disease was 6 percent over the 75 years—a decline that correlated with changes in body mass and stature. Heart disease was 2.9 times more common in the 1910 cohort of veterans than it was for veterans in 1985-1988. This work, for which Fogel won the 1993 Nobel Prize in economics, is consistent with the antenatal nutrition model.

Micronutrients may have long-term effects on disease. Zinc governs birth weight, and males are susceptible to gestational zinc deficiency (Andrews, 1992; Hales et al., 1991). Zinc deficiency affects both adult-onset diabetes mellitus and schizophrenia, diseases whose incidence is correlated. Recently, it was recommended that women of child-bearing age take folic acid supplements because deficiency early in fetal development is responsible for 60 percent of birth defects of the neural tube—spina bifida, for example, Vitamin B and other deficiencies may be related to late-age dementia (Zaman et al., 1992; Martin et al., 1992). Thus, there is a linkage of health in the antenatal and later life stages due to deprivation of both macro- and micro-nutrients at childbearing ages. If maternal nutrition varies over cohorts (and, within cohorts, by socioeconomic status at childbearing ages), then those effects must be distinguished from genetic factors. What look like genetic effects could be the effects of low socioeconomic and cultural status that persist in families from one generation to another.

Immunologically Related Diseases: Interactions of Viral and Nutritional Factors

Nutrition affects the immune system. Some chronic diseases, are due to early viral infections; for example, cytomegalia virus is implicated in CVD (Mozar et al., 1990). Viruses may trigger autoimmune diseases (like rheumatoid arthritis and systemic lupus erthymatosis). Some of these diseases may moderate with age. Other diseases like humoral autoimmunity (i.e., the prevalence of antinuclear antibodies) or multiple myeloma (a form of cancer) may increase with age (Beregi et al., 1991). Nutritional supplements may be important in changing immunological responses with age. For example, age-related loss of gastric immunity is reversed by supplementation with vitamins A, C, and E (Penn et al., 1991a,b).[7] Other examples include recent studies showing significant effects, starting after 1 or

[7] In noninstitutionalized healthy persons aged 66-86, those receiving *balanced* supplements of vitamins and minerals had improved immune function and fewer days with illnesses due to infection than controls (23 versus 48 days; Chandra, 1992).

2 years, of antioxidant supplements—beta carotene, vitamin E, and selenium—on total, cancer, and stroke mortality (Blot et al., 1993).

Nutritional and other types of supplementation for the elderly is complex because of the need to maintain homeostasis. CVD is reduced by estrogen replacement, a result correlated with improvement in status on multiple risk factors (Nabulsi et al., 1993). However, when that therapy is combined with vitamin D, *lean* women showed no improvement in cholesterol (Mysrup et al., 1992). Hypercalcemia, produced by vitamin D, raised CVD risk without an increase in cholesterol (Moon et al., 1992). Thus, though nutritional and hormonal supplementation are important at late ages, its parameters, and their linkage, are not yet clear. Furthermore, the most biologically active form of many micronutrients is not known.[8] Consequently, trials of nutritional interventions must rely heavily on laboratory data (Prasad and Edwards-Prasad, 1992).

Multiple Diseases, Host Factors, and Their Interactions at Late Ages

Analysis of age differences in disease and risk-factor processes requires biologically detailed models in which failure is multidimensional, each dimension potentially having its own time scale. A state-space model has this capability if a θ is assumed for each disease. For breast cancer and Alzheimer's disease, one must identify early and late disease with different etiologies, genetic determinants, and rates of progression. In Manton et al. (1993c) the quadratic estimated from all deaths behaved differently from a quadratic that was the sum of three disease-specific functions (with a single θ). Time functions can differ by disease: the quadratic for cancer could be estimated with a Weibull—not a Gompertz. *M* causes, with different θs, can be summed if the causes are disjoint (Manton and Stallard, 1988).

Some life-cycle effects, if $\underset{\sim}{x}_{it}$ explains much of the variation associated with θ, can be represented in equation (1). For example, adult-onset DM lowers the age at death for multiple conditions (Goldstein et al., 1978; Jones, 1956). So, DM could be expressed as a rapid increase of blood glucose (and its variance) with age in (1), which increases mortality by raising risk-factor levels in (2). For persons treated for DM, a person's variability of blood glucose is an important measure of risk—even, possibly, for dementia (Sachon et al., 1992).

Exogenous factors, whose effects vary with age, may be used to link health and socioeconomic factors. The adverse effect of low income on health may be represented by the effect of $\underset{\sim}{y}_{it}$ on risk factors. If health

[8] An isomer of vitamin E, α tocopherol succinate, is active as an anti-oxidant and a redifferentiating agent (Prasad and Edwards-Prasad, 1992); other isomers of vitamin E are not.

affects retirement, then retirement could be both an outcome and a cause of a change in health. Thus, a state-space model can represent exogenous inputs influencing health and nonlinear risk-factor processes.

Life-cycle effects differ by sex and race. Fertility may affect mortality from chronic diseases, like CVD and breast cancer (Beral, 1985; MacMahon, 1973). Postmenopausally, lower estrogen levels lead to female osteoporosis *and* atherosclerosis. African-Americans have elevated risks of hypertension and of renal failure, which peak in late mid-life (Walker et al., 1992; Brancati et al., 1992).[9]

DISABILITY AND MORTALITY

Disability is a complex phenomenon that manifests itself in many ways and that evolves over a long time. Thus, the definition of disability is subject to measurement and conceptual difficulties. But the attempt to measure disability is important because, given its relation to Medicare use and costs, and to morbidity and mortality, disability has strong predictive validity (Manton et al., 1993c). Moreover, functional impairment is important because of its prevalence at late ages and its association with decreased autonomy and increased demand for long-term care (LTC). One measure of functioning is the number of years one can expect to live free of disability, that is Active Life Expectancy (ALE) (Katz et al., 1983). ALE can be calculated from single- or multiple-decrement life tables and from cross-sectional or longitudinal surveys (Sullivan, 1971; Crimmins et al., 1989; Rogers et al., 1989; Manton and Stallard, 1991).

The assessment of the population impact of disability needs refinement. In most studies, a discrete threshold for disability, constant across age, is used to define the "impaired" population as those who require help in the activities of daily living (ADLs)—dressing, bathing, eating, and so on; or instrumental activities of daily living (IADLs) (Lawton and Brody, 1969). A "threshold" model of disability has two limitations. First, there will be people who are close to the threshold, but above or below it. They will

[9] End-stage renal disease (ESRD) may be reduced in African-Americans (and in whites as well) by better control of hypertension, blood glucose, and use of ACE-II inhibitors. Treatments changed between 1977 and 1987, when the peak incidence of ESRD changed from the fourth to fifth decade of life (Qualheim et al., 1991). African-American women have elevated DM risks, so that mortality increases in middle and late middle age. The age trajectory of cholesterol differs for African-American and white females (Knapp et al., 1992). The CVD risk of African-Americans, and possibly Hispanics, may be reduced by lowering sun-induced production of calciferol (Moon et al., 1992), or by lowering serum Lp(a) in Hispanics (this is a lipoprotein stabilizing thromboses; Haffner et al., 1992). Hispanics have lower CHD risk despite having *more* obesity, and DM, higher waist-hip ratios, and greater insulin resistance.

have higher misclassification rates than do persons with no disability or with severe disability. Depending on where the threshold is set, large proportions of persons may be misclassified if the time derivative of the age distribution of disability is large. Second, the oldest-old will have a high prevalence of partial disability, though only a small proportion may be severely disabled: some disability, after all, is due to treatable or preventable conditions (Marx et al., 1992; Taylor, 1993).[10]

To deal with measurement error, and with different types and intensities of disability, multivariate procedures can be used to estimate scores for disability dimensions affecting persons at different ages due to different diseases. When multiple discrete measures of disability are projected onto a multidimensional "fuzzy" state space (Manton and Stallard, 1991), if, say, one of 27 disability items is miscoded, an individual's score changes incrementally: he does not jump from a disabled to a nondisabled state. Scores more precisely assess the type and intensity of disability (see Maddox and Clark, 1992). And, they better describe covariate effects; for example, disability for a fixed level of physical disease may be negatively correlated with education as in the case of osteoarthritis (Hannan et al., 1992). Scores may better describe short episodes of disability and improvements in functional status for individuals. With scores, changes in the intensity of disability can be described in autoregressive functions like equation (1).

Scores (properly scaled) can be used to partition life expectancy into components specific to disability type. By representing within-class heterogeneity they behave better stochastically because diffusion, though bounded, is continuous. In the NLTCS, scores were calculated from 10 ADL, 8 IADL, and 9 physical performance items (like difficulty in climbing stairs and in holding a 10-pound package). We estimated male and female life tables (for the 1982-1989 NLTCS and mortality for 1982-1991) for seven dimensions identified from the 27 items for models in which a person is a member of one class (a discrete-state model) or has partial membership in multiple classes (a fuzzy-state model). A discrete-state model was implemented by fixing the covariance matrix in equations (6) and (8) at 0.0. Doing so yields a homogeneous population process comparable to the heterogeneous population process modeled in equations (5) through (9) except for the effects of altering the covariances. Alternatively, a Markov transition model could be constructed by classifying individuals into the state in which they had the highest disability score. Since that model does not use equations (5) through (9), differences in outcomes are confounded with differences in model structure.

In Table 7-3 we combined the seven dimensions, into four groups.

[10] One example is impairment due to cataracts, which costs Medicare $3.2 billion per year.

Although life expectancy at 65 is similar if not identical for the two models, survival declines *less* rapidly for the discrete-state model for *both* sexes to age 75. The prevalence of disability increases faster in the discrete-state model because, with only between-class heterogeneity, mortality increases only when a person "jumps" to a more disabled state. In the fuzzy-state model there is within-class heterogeneity that mortality selects against; that is, as a person's scores on severely disabled dimensions increase with age, interactions for the pair wise (but partial) occupancy of states allows mortality to increase continuously with age. In the discrete-state model, mortality is downwardly biased until sufficient proportions move into states with high mortality. The discrete-state model generated increases in the proportion in severely impaired and institutional groups inconsistent with the 1984-1986 Longitudinal Study of Aging (LSOA).[11]

The age trajectories for the two models are shown in Figure 7-4 for the least and the most impaired classes. The two discrete-state trajectories for males converge faster than the fuzzy-state trajectories starting at age 75. For females, convergence is also faster in the discrete-state model, though it occurs later. The slower covergence for males is consistent with their shorter survival time at any disability level and age. For both sexes, the age-specific prevalences of low and high disability cross over in the discrete-state model. Fuzzy-state trajectories do not. The fuzzy-state model illustrates the effects of interactions of nonlinear age increases in mortality and linear disability dynamics produced in equations (5) through (9). With age, the "average" health of the population approaches stable points in a convex state space because of the moving equilibria of prevalence on multiple disability dimensions and increases in states with high mortality. The equilibria models, like extreme-value hazard models, represent isomorphisms between the statistical mechanics of population health and the kinetics of aging for individuals. Thus, the "strange attractor" (nonlinear change) behavior observed at late ages is due to failure mechanisms becoming more complex with age. At early ages, death is often due to the catastrophic failure of one system. At late ages, it reflects the overwhelming of homeostasis by the accumulation of loss of function in multiple organs. This is why the age trajectory of functional loss predicts mortality well.

Analyses of the NLTCS indicate that the prevalence of disability de

[11] In that study 33 percent of persons aged 80 and older are physically robust, that is, they have no difficulty on five physical tasks; 49 percent have no difficulty walking a quarter of a mile; 57 percent have no difficulty climbing a flight of stairs (Suzman et al., 1992). Branch and Ku (1989) followed persons aged 85+ for 15 months and found that 55 percent were ADL independent as were almost 50 percent of 160 centenarians followed for 8 years in Shanghai (Zheng et al., 1993).

TABLE 7-3 Cohort Life Tables and Disability Scores for Males and Females, With and Without Heterogeneity Within Classes Eliminated; Estimates for Persons Reaching Age 65 in Mid-1980s

				Percent of Life Expectancy at Age t in Class			
Age t	Model Type[a]	Proportion Surviving to Age t, l_t (%)	Life Expectancy at Age t, e_t (years)	Little Impairment; No Physical and Mild or no Cognitive Disability	Moderate Physical Impairment	Heavy Physical Impairment	Extreme Impairment: Moderate ADL, Frail, and Institutionalized
Males							
65	Fuzzy state	100.0	15.6	96.3	0.7	0.6	2.4
	Discrete state	100.0	15.4	93.3	0.7	0.6	2.4
75	Fuzzy state	69.2	10.3	94.0	0.8	1.0	4.3
	Discrete state	69.7	9.8	92.1	1.0	1.3	5.7
85	Fuzzy state	33.0	6.1	84.7	1.3	2.4	11.6
	Discrete state	32.5	5.3	73.9	2.0	3.7	20.5
95	Fuzzy state	6.3	3.4	70.1	1.6	5.3	23.0
	Discrete state	4.0	2.3	34.6	2.8	8.6	54.0
105	Fuzzy state	0.3	2.4	72.0	0.2	3.5	24.3
	Discrete state	0.0	1.1	11.3	0.9	4.9	82.8

Females							
65	Fuzzy state	100.0	20.9	95.6	1.0	0.7	2.7
	Discrete state	100.0	20.9	95.6	1.0	0.7	2.7
75	Fuzzy state	82.6	14.1	91.8	1.3	1.2	5.7
	Discrete state	83.3	14.0	90.1	1.6	1.4	6.8
85	Fuzzy state	55.2	8.5	76.6	2.2	2.8	18.5
	Discrete state	56.7	8.0	67.9	3.2	3.5	25.4
95	Fuzzy state	19.5	5.0	57.4	1.9	5.0	35.7
	Discrete state	18.7	4.0	29.4	3.3	6.1	91.3
105	Fuzzy state	2.5	3.8	58.1	1.1	5.0	35.8
	Discrete state	1.1	2.3	8.8	1.6	3.7	85.9

[a]In the fuzzy state model, an individual can belong to more than one class.

SOURCE: Data are from the 1982, 1984, and 1989 National Long-Term Care Surveys.

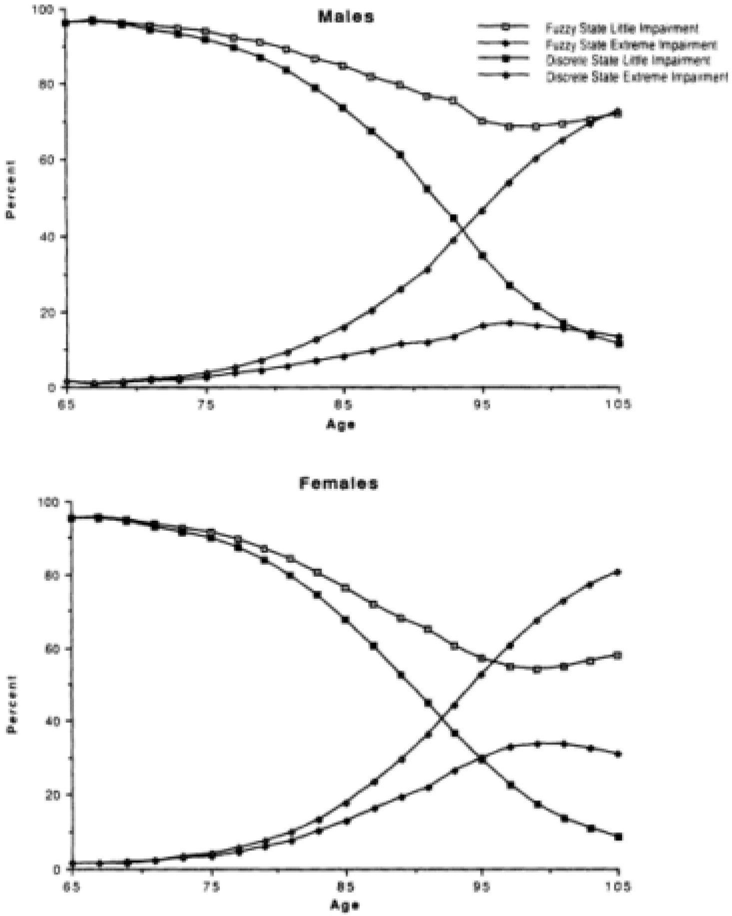

Figure 7-4
Comparing discrete to fuzzy-state models. SOURCE: Data are from the 1982, 1984, and 1989 National Long-Term Care Surveys.

TABLE 7-4 The 1982, 1984, and 1989 Prevalence of Chronic Disability in the U.S. Population Age 65 and Over Estimated from the 1982, 1984, and 1989 National Long-Term Care Surveys

Disability	Population (thousands) with			Percentages and SE Differences (%) with SE and *t* Test		1982-1989,
Level	1982	1984	1989	1984-1989	1982-1989	Age Standardized
Nondisabled	20,548	21,403	23,906	1.1	1.1	1.7
	76.3(±0.30)	76.3(±0.29)	77.4(±0.30)	(±0.42;*t*=2.6)	(±0.42;*t*=2.6)	(±0.42;*t*=4.1)
IADLs only	1,434	1,590	1,360	-1.3	-0.9	-1.4
	5.3(±0.16)	5.7(±0.16)	4.4(±0.14)	(±0.21;*t*=6.2)	(±0.21;*t*=4.3)	(±0.21;*t*=6.7)
1-2 ADLs	1,740	1,831	1,993	0.0	0.0	-1.2
	6.5(±0.17)	6.5(±0.17)	6.5(±0.17)	(±0.24;*t*=0.0)	(±0.24;*t*=0.0)	(±0.24;*t*=-5.0)
3-4 ADLs	732	797	1,079	0.7	0.8	0.7
	2.7(±0.11)	2.8(±0.11)	3.5(±0.13)	(±0.17;*t*=4.1)	(±0.17;*t*=4.2)	(±0. 7;*t*=4.2)
5-6 ADLs	937	882	848	-0.4	-0.8	-0.9
	3.5(±0.13)	3.1(±0.12)	2.7(±0.11)	(±0.16;*t*=2.5)	(±0.17;*t*=4.7)	(±0.172;*t*=5.3)
Institutional	1,532	1,538	1,685	0.0	-0.2	-0.4
	5.7(±0.16)	5.5(±0.16)	5.5(±0.16)	(±0.23;*t*=0.0)	(±0.23;*t*=0.9)	(±0.23;*t*=-1.7)
Total Population	26,924	28,042	30,871			

NOTE: SE = standard error.

SOURCE: Data are from the 1982, 1984, and 1989 National Long-Term Care Surveys.

creased from 1982-1989 (Manton et al., 1993a). In Table 7-4 are estimates of prevalence in 1982, 1984, and 1989 for six groups: (1) not disabled; (2) disabled only for IADLs; (3) disabled on 1 or 2 ADLs; (4) disabled on 3 of 4 ADLs; (5) disabled on 5 or 6 ADLs; and (6) institutionalized. The 1.1 percent increase in the proportion of nondisabled from 1982 to 1989 is significant. It represents a 4.7 percent relative decline in the prevalence of disability. Because the U.S. elderly population grew 14.7 percent between 1982 and 1989, *and* also became older, the age-standardized rate of disability declined 1.7 percent; the age-and sex-standardized rate declined 2.8 percent. Reductions in the incidence of disability were large at late ages—even adjusted for mortality. At age 85 the mortality-adjusted likelihood of becoming disabled in 5 years declined 23.2 percent between 1982-1984 and 1984-1989 (Manton et al., 1993a).

The prevalences in Table 7-4 require no assumptions about between-surveys transitions or calculations of scores. The validity of these declines may be examined by comparing them with covariates with known trends. They are consistent with declines in population-weighted proxy response rates (indicative of severe impairment) from 19.8 percent (1982) to 17.6 percent (1989). Because the use of a proxy is determined before an interview, rates are unlikely to be affected by the reassessment of an individual. The use solely of equipment to cope with disability increased both absolutely and relatively from 1982 to 1989—suggesting a reduction in disability and an increase in social autonomy within the disabled population (Manton et al., 1993b). The use of equipment with personal assistance increased. Only the use of personal assistance by itself declined. Thus, decreases in informal care due to higher participation by women in the labor force and to smaller family size may be compensated for by use of equipment.

The 1982, 1984, and 1989 NLTCS and the 1982-1991 Medicare mortality data were used to construct cohort life tables based on disability scores. Cohort life expectancy at age 65 was 15.6 years for males and 20.9 years for females in 1989—increases from 14.2 years and 18.6 years, respectively, in 1982-1984. These life expectancies are projected to be achieved in 1993 for males and by 2010 for females in Census mid-range projections (Day, 1993), and in the low-mortality variant for females by 2003. Thus, the male values are conservative. The age trajectories of the seven disability dimensions, with mortality effects removed, are shown in Figure 7-5 by sex for 1982-1984 and 1982-1989. Before comparing results, we first note procedural differences. The results are based on changes in disability between 1982 and 1984 surveys and mortality between 1982-1986. The 1982-1989 analysis had to deal with different follow-up intervals (2 versus 5 years). This difference was handled by assuming that scores estimated for a survey are constant over the follow-up interval. While this practice permits estimates to be made on a monthly basis, with equal intervals, a strong

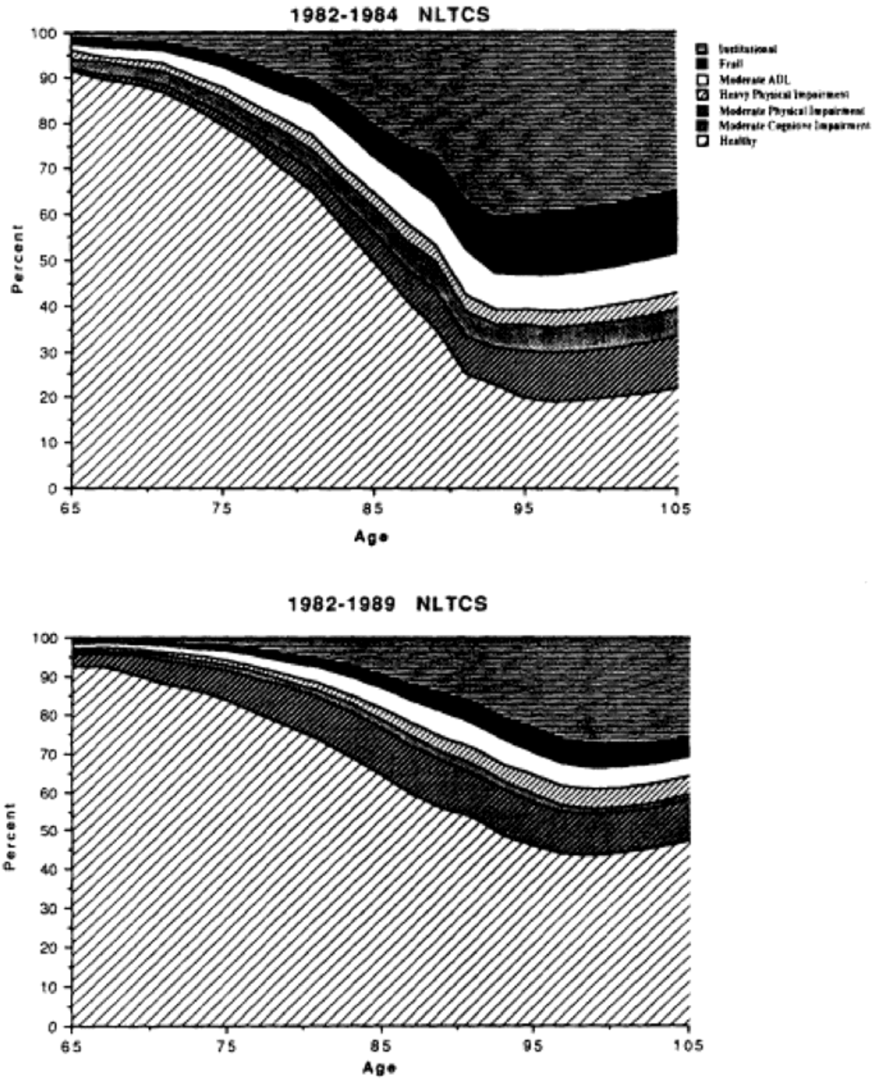

Figure 7-5
Female distributions of seven disability types produced from state-space models.
SOURCE: Data are from the 1982, 1984, and 1989 National Long-Term Care Surveys.

mortality gradient makes the imputed population appear healthier at late ages. However, estimating mortality coefficients with the imputed monthly data to remove survival bias yields accurate life tables. Bias in health scores is less of a problem if it is recognized that the scores describe a mixture of the current state of the population, and the state at a previous survey date (an average of 1 or 2 1/2 years earlier). Thus, changes in Figure 7-5 reflect the effects of improvements from 1982 to 1989 (Table 7-4) and the use of imputed monthly data. We investigated several methods for imputing monthly disability data using other dynamic assumptions and found that the results were similar (Manton et al., 1994b). Estimates of disability for 1982-1989 increase less rapidly with age than do those for 1982-1984—similar to the slowing of mortality age increases in Carey et al. (1992) and Curtsinger et al. (1992). This finding may reflect diseases associated with different life stages. Disabling conditions have peak effects at different ages; for example, DM peaks before 65 to 70; osteoarthritis before 75; and Alzheimer's disease before 90. For DM, this pattern is related to a lower life expectancy; for osteoarthritis, it may be due to the trajectory of the disease process; for Alzheimer's, the cause may be the exhaustion of susceptible persons.

In analyses of the Longitudinal Study of Aging, education was significantly related to robustness. Persons with 9 or more years of education had 2.1 to 2.4 times the likelihood of remaining robust than persons with 6 or fewer years had. Thus, declines in disability are consistent with cohort changes in education in Table 7-5. Above age 85, life expectancy and active life expectancy increased for the group with low education (8 or fewer years). Life expectancy for males in this group increased a year while active life expectancy increased 1.9 years—nearly twice as fast. Life expectancy for better-educated males increased a year; active life expectancy 0.4 year. Life expectancy and active life expectancy were absolutely higher in high-education groups (4.8 versus 7.3 years) in 1982-1989. Females manifest similar patterns. *Overall* life expectancy and active life expectancy increased for women more than for men for each education group because of the rapid growth of high-education groups above 85. Between 1980 and 2015 the proportion of persons 85 to 89 with 8 or fewer years of education is projected to decline significantly (Preston, 1992). Consequently, because education and function are associated, active life expectancy is expected to improve (Maddox and Clark, 1992; Suzman et al., 1992).[12]

[12] The changes in the education of cohorts 85-89 may be compared with projections made by Preston (1992) using 1980 census data and education-specific mortality for 1960 (Kitagawa and Hauser, 1973). For 1980, Preston estimated that 54.7 percent of females aged 85-89 had 8

Our model can be compared with disability data weighted by time of exposure. Figure 7-6 presents observed data (including imputed monthly data) and model-generated age trajectories for the least disabled for 1982-1989. The model fits the data well: there is little trend in the residuals for either sex. For both sexes, there is a flattening, and then a slight increase, for the least disabled at late ages. One source of this pattern is suggested by the trajectories for the most disabled community residents (Figure 7-7). The prevalence of the most disabled class declines above age 95, similar to risk-factor dynamics: the force of mortality is so high for the oldest old in this group that they cannot survive ill for very long.

Figure 7-8 plots sex-specific age trajectories for the least disabled group, as observed and as modeled, for each survey year. To smooth these data we plotted scores averaged over ages *t* to 105:

$$\bar{g}_1(65) = \left(\sum_{t=65}^{105} \bar{g}_{it} \right) \Big/ (105 - 64) .$$

At 65, we plot the average score for 65 to 105; then the average for ages 67 to 105, and so on. The trajectory of model-generated scores for the least disabled fits the data well. In Figures 7-9 and 7-10 we plot the trajectories for the least and most disabled using smoothed data for males and females. The data and the model results are similar. In both, severe disability declines at late ages. These results, unlike the prevalences reported in Table 7-4, depend on model assumptions. The scores are more reliable because they are a weighted average of multiple functional items. Figure 7-5 can be compared with the results of a model in which groups are defined by IADL-only disability, 1 to 2 ADLs, 3 to 4 ADLs, 5 to 6 ADLs (physical performance is *not* represented). The 5-year transition matrix for persons age 65 is given in Table 7-6. The extrapolation of these transitions (by multiplying the four transition matrices for persons age 65, 70, 75, and 80) produces the distribution in Table 7-7. The proportion remaining nondisabled is, adjusting for mortality, 58 percent—close to the value for the least disabled at age 85 depicted in Figure 7-5. Thus, discrete-state changes are similar to score trajectories for times and ages where a comparison is possible.

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or fewer years of education compared with our 1982 estimate of 59.3 percent. Our 1989 estimate is 48.6 percent. Preston's 1990 estimate is 44.0 percent. Thus, our estimates for females with low education are 4 percentage points higher than Preston's. Our decline from 1982-1989 (10.7 percent) is identical to his 1980-1990 decline. Thus, agreement is good, given that his projections use education-specific mortality ratios from 1960 (that is, pre-Medicare). Our decline for low-education males 85 and older is 18.9 percent, 1982-1989, compared with Preston's projection of 8.7 percent. His projections for males did not use education-specific survival, possibly explaining the difference.

TABLE 7-5 Life Expectancy and Active Life Expectancy for Males and Females 1982-1984 and 1982-1989 at Age 85; Total and Stratified by Education

	Males			
Period	Percentage of Life Years Expected to be Lived at a Given Education Level	Life Expectancy (years)	ALE (years)	Proportion of Life Active (%)
Total				
1982-1984	—	5.0	3.1	61.8
1982-1989	—	6.1	4.4	72.5
Change	—	+1.1	+1.3	
Low education[a]				
1982-1984	64.7	3.8	1.2	30.8
1982-1989	40.8	4.8	3.5	72.9
Change	-23.9	+1.0	+1.9	
High education[b]				
1982-1984	35.5	6.3	5.0	79.1
1982-1989	59.2	7.3	5.4	74.0
Change	+23.9	+1.0	+0.4	

[a]Eight years or less of education.
[b]Nine years or more of education.

SOURCE: Data are from the 1982, 1984, and 1989 National Long-Term Care Surveys.

GENETICS

Models and Methods

The effects of genetics on longevity are complex. Models in which a single gene controls biological senescence are obsolete. Genetic influences are polygenic, and the expression of genetically determined traits depends on environment. To estimate the effects of genetics on population health

Females			
Percentage of Life Years Expected to Be Lived at a Given Education Level	Life Expectancy (years)	ALE (years)	Proportion of Life Active (%)
—	6.3	3.1	49.6
—	8.5	5.5	64.3
—	+2.2	+1.4	
81.7	4.6	0.9	19.6
62.5	5.6	3.6	64.2
-19.2	+1.0	+2.7	
18.3	9.3	6.4	68.7
37.5	10.3	6.7	70.9
+19.2	+1.0	+0.3	

one must posit a model of these effects and compare the actual to the theoretical distribution of events. Such model-based integration of data, and indirect inference, is often used in medical demography. Often, problems involving latent variables must be dealt with in genetic models: some are time-constant effects such as fixed genetic factors, and some are time-variable effects. Though the terminology changes with the topic being addressed, the mathematics and statistics are similar (for example, the assumption of local independence, Suppes and Zanotti, 1981; or the missing-

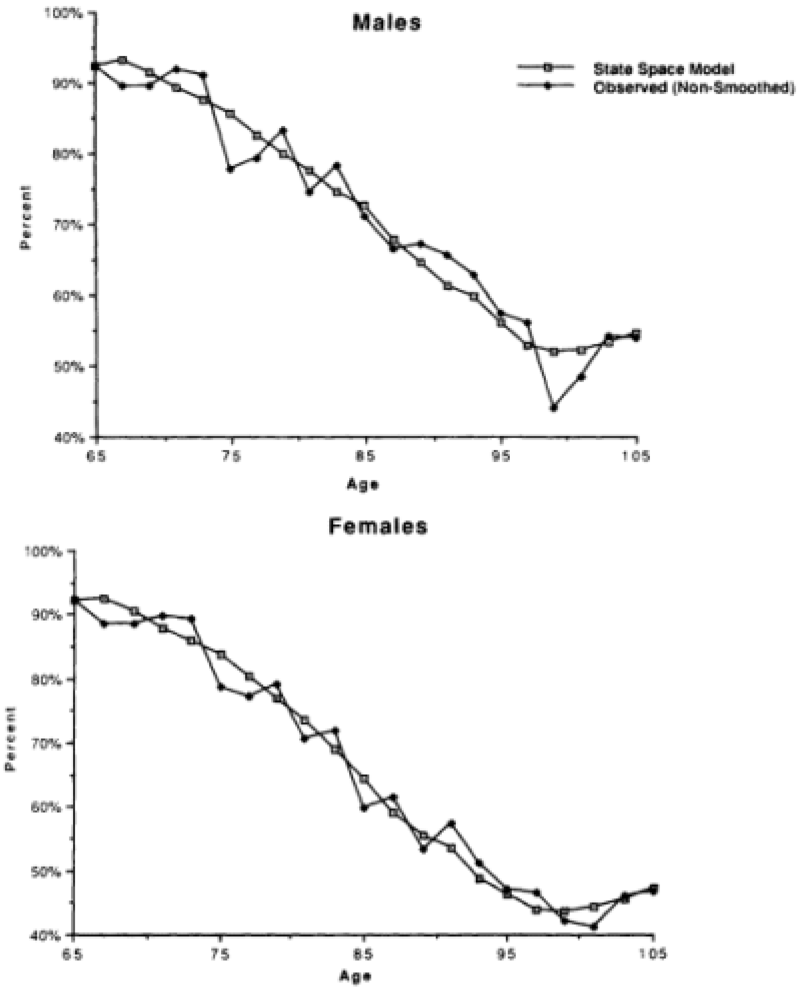
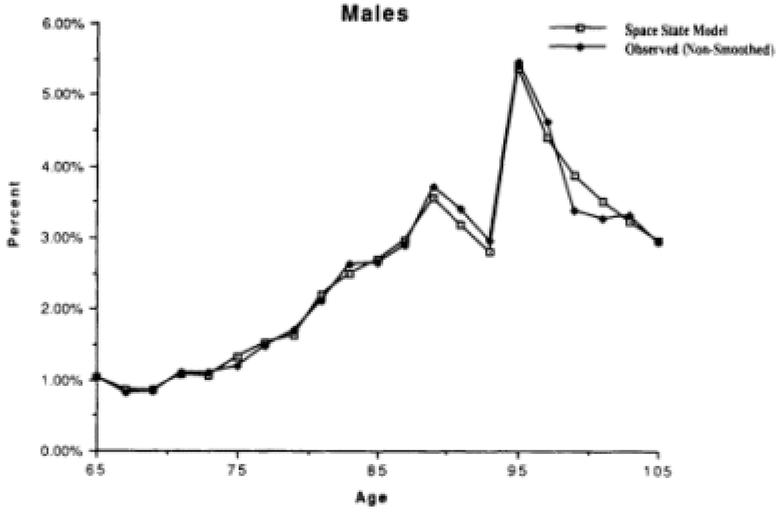


Figure 7-6
Comparing observed monthly mean scores to state-space model, predictions for the category "healthy" using combined survey data. SOURCE: Data are from the 1982, 1984, and 1989 National Long-Term Care Surveys.



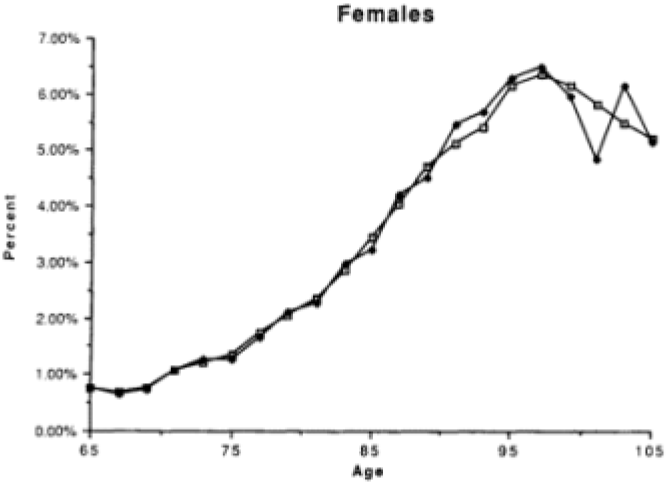


Figure 7-7
Comparing observed monthly mean scores to state-space model, predictions for the category "frail" using combined survey data.
SOURCE: Data are from the 1982, 1984, and 1989 National Long-Term Care Surveys.

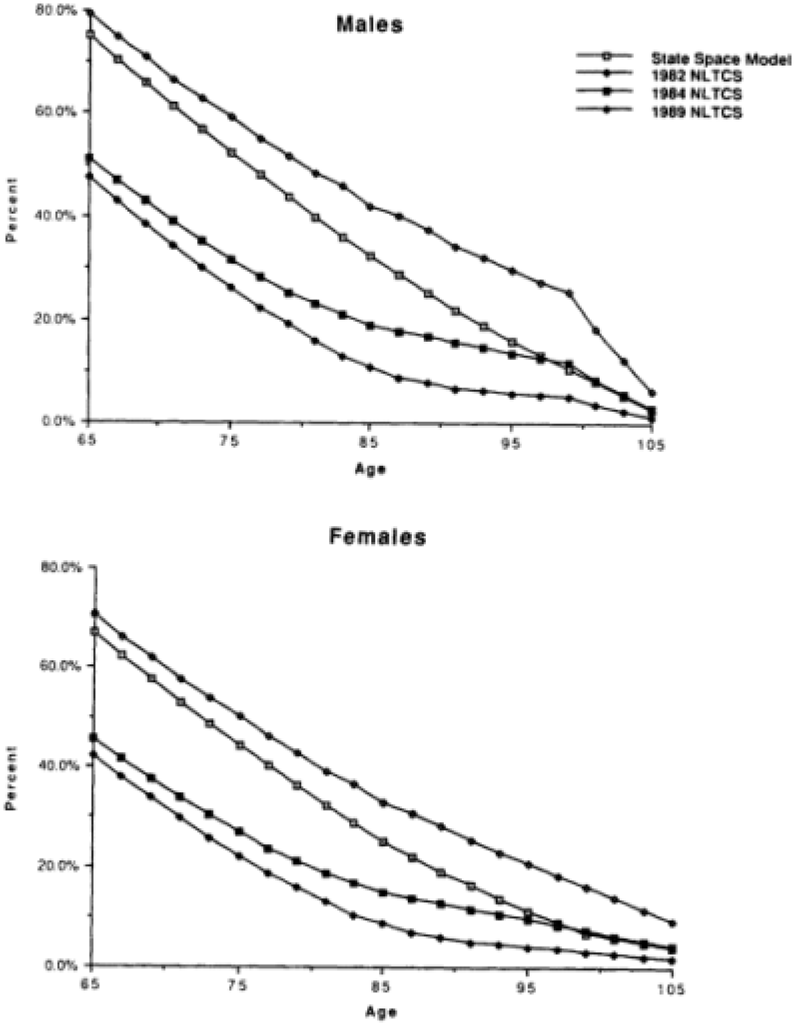


Figure 7-8

Comparisons of the observed smoothed mean monthly scores for the category "healthy," in the three surveys to the predicted smoothed scores in the state-space model.

SOURCE: Data are from the 1982, 1984, and 1989 National Long-Term Care Surveys.

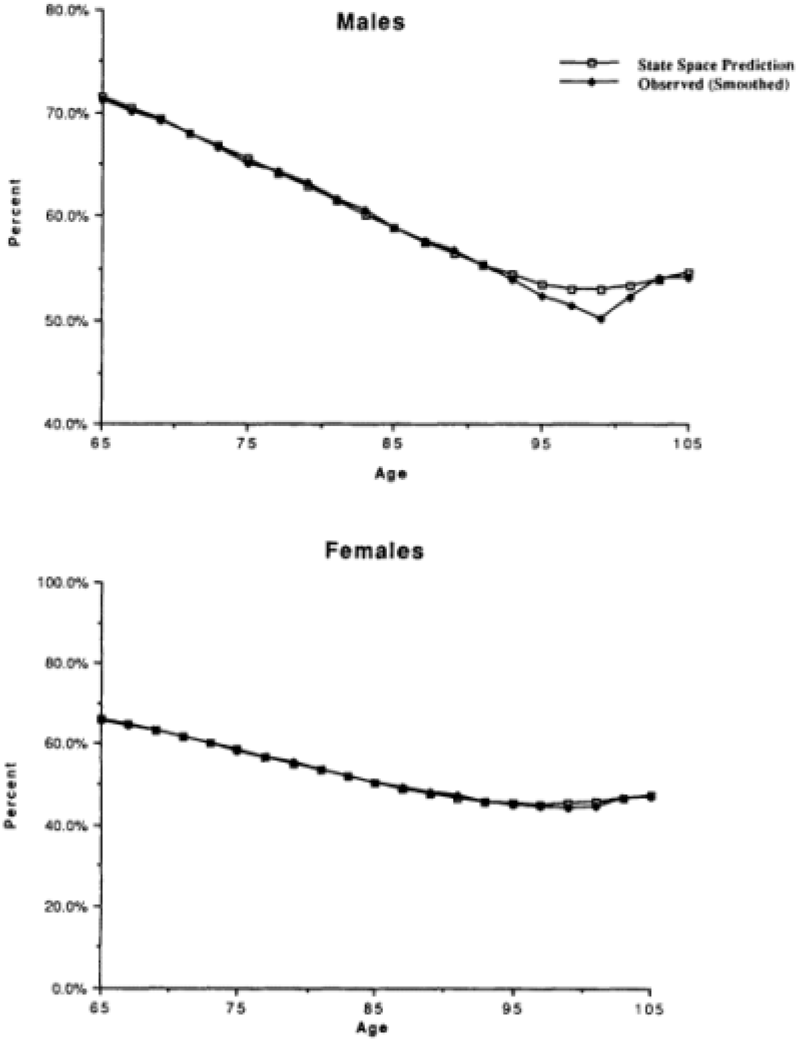


Figure 7-9
Comparing the smoothed mean monthly scores for the category "healthy" from the three surveys combined to the values predicted by the state-space model. SOURCE: Data are from the 1982, 1984, and 1989 National Long-Term Care Surveys.

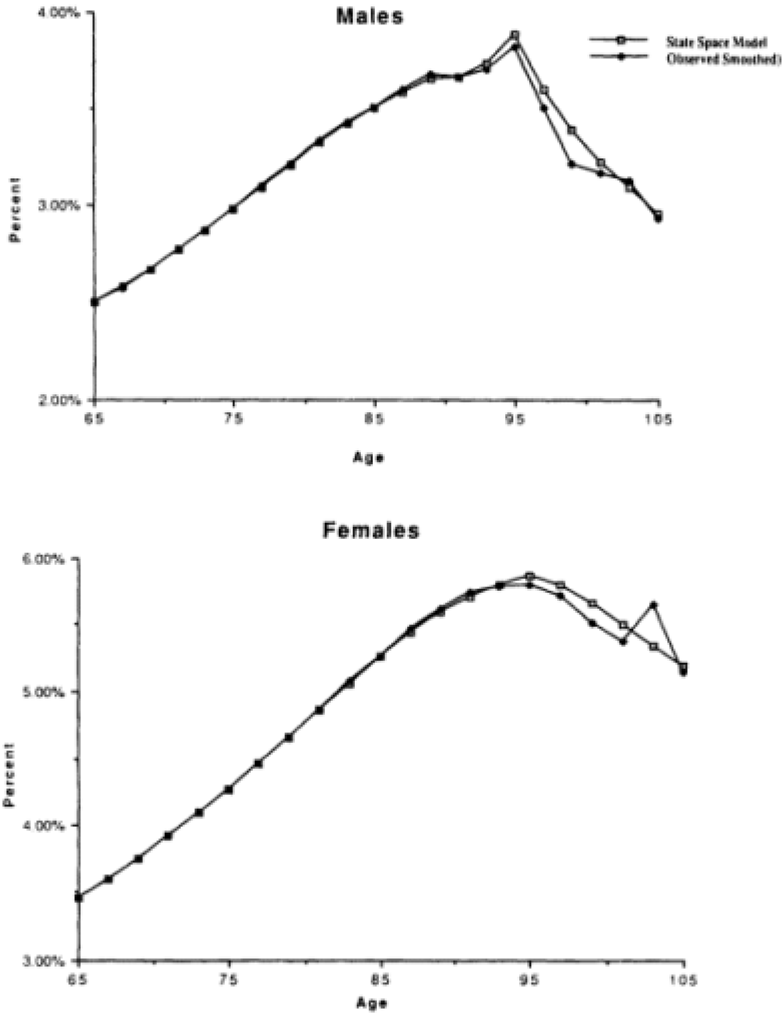


Figure 7-10
Comparing the smoothed mean monthly scores to the state-space model prediction for the category "frail" for all three surveys combined.
SOURCE: Data are from the 1982, 1984, and 1989 National Long-Term Care Surveys.

TABLE 7-6 Five-Year Transition Probabilities from Age 65-70 Estimated from the 1984 to 1989 NLTCS, With and Without Mortality Adjustments

Status at Age	Status Age 70 in 1989						
65 in 1984	Nondisabled	IADL Only	1-2 ADLs	3-4 ADLs	5-6 ADLs	Institutional	Dead
Nondisabled +age-ins	.800	.026	.032	.012	.011	.009	.111
(excluding dead)	.900	.029	.036	.014	.012	.010	—
IADL only	.228	.158	.220	.049	.031	.043	.272
(excluding dead)	.314	.217	.302	.067	.042	.059	—
1-2 ADLs	.147	.074	.250	.136	.050	.073	.270
(excluding dead)	.202	.101	.343	.187	.069	.100	—
3-4 ADLs	.015	.042	.200	.199	.154	.050	.339
(excluding dead)	.023	.063	.303	.301	.234	.076	—
5-6 ADLs	.038	.019	.082	.089	.156	.096	.520
(excluding dead)	.079	.040	.171	.185	.325	.200	—
Institutional	.000	.019	.011	.012	.012	.553	.393
(excluding dead)	.000	.031	.018	.019	.020	.912	—

SOURCE: Data are from the 1984 and 1989 National Long-Term Care Surveys.

TABLE 7-7 Twenty-Year Transition Probabilities for Age 65-85 Estimated from the 1984 to 1989 NLTCS, With and Without Mortality Adjustments

	Status at Age 85						
Status at Age 65	Nondisabled	IADL Only	1-2 ADLs	3-4 ADLs	5-6 ADLs	Institutional	Dead
Nondisabled +age-ins	.218	.024	.041	.025	.019	.047	.626
(excluding dead)	.583	.063	.110	.066	.050	.127	—
IADL only	.088	.012	.026	.018	.013	.035	.808
(excluding dead)	.456	.065	.134	.092	.069	.184	—
1-2 ADLs	.063	.010	.023	.016	.012	.034	.841
(excluding dead)	.397	.064	.142	.104	.077	.217	—
3-4 ADLs	.025	.006	.016	.013	.010	.028	.901
(excluding dead)	.253	.063	.166	.134	.100	.285	—
5-6 ADLs	.021	.004	.011	.008	.006	.020	.930
(excluding dead)	.296	.060	.151	.116	.089	.289	—
Institutional	.006	.002	.007	.004	.003	.030	.947
(excluding dead)	.114	.038	.125	.081	.066	.577	—

SOURCE: Data are from the 1984 and 1989 National Long-Term Care Surveys. Estimates are the results of multiplying the 5-year transition matrices for ages 65 (see Table 7-6), 70, 75, and 80.

information principle; Orchard and Woodbury, 1971). A combination of models from the two areas could be beneficial. One possibility would be to combine analyses of the genetic control of aging with stochastic-process models using fuzzy-state mapping of discrete traits to allow evaluation of high-dimensional discrete spaces, and their mapping to nonstationary stochastic processes, without Gaussian assumptions.

Weiss (1990) reviewed standard approaches for analyzing the genetics of chronic diseases. One method assumes that phenotype is controlled by the *additive* effects of a gene locus (G), a component representing all *other* genetic determinants (PG), and environment (E). The distribution is

$$P = G + PG + E \,, \tag{10}$$

$$\mu_p = \sum_g \mathrm{Prob}(g)\mu_g \,, \tag{11}$$

$$\sigma_p^2 = \sigma_g^2 + \sigma_{pg}^2 + \sigma_e^2 \,. \tag{12}$$

(See, for example, Elston, 1981, 1986). This does not produce a one-to-one mapping of genotype and phenotype. The population is composed of subsets of individuals for each genotype with mean μ_g and variance (σ_{pg}^2 + σ_e^2). The presence of a gene locus produces a nonnormal distribution. This model can be fitted to family disease pedigrees with μ's and σ's estimated by maximum likelihood to identify genetic effects. A limitation of the model is the effect of individual differences in exposures. Exposure effects can be assumed to be normally distributed if independently generated. This assumption fails if there are interactions between genotype and environment (G x E). These may be studied in experiments using animal models with well-characterized genetic traits (for example, Curtsinger et al., 1992) or in human studies of identical twins (a natural experiment in which genetic endowment is identical but must be contrasted with same-sex fraternal twins to control for environmental variation). Effects, however, are not identifiable in this case *unless* the gene loci are identified.

Thus, identifying the genetic effects on health can require multiple data sets, such as laboratory analyses identifying genes, family history, or data on identical twins. The problems are more complex when one gene affects multiple phenotypes, that is, pleiotropy. For example, the genetic control of an enzyme, 5 alpha reductase, which converts testosterone into dihydrotestosterone, affects the risk of both baldness and prostate cancer. The correlation of trait expression can be used to analyze how a gene of interest is related to genes whose location on o chromosome is known (Ott, 1985). Modifications of the Elston-Shinant algorithm can represent covariates in these relations. A model based on the correlation of continuously distributed risk factors between a random pair of relatives and its effect on the probability of being affected by a risk factor, modeled as a logistic, is less computationally burdensome (Hopper and Carlin, 1992). A moderately frequent appearance of a disease in a family over time may imply strong familial risk factors.

Hazard functions are often nuisance parameters in genetic epidemiology. In medical demography the age dependence of health events is often a primary concern, for example, the rectangularization of the survival curve, the compression of morbidity, and the plasticity of aging. Weiss (1990) suggests that, to analyze age effects, one must relate genotype to disease risk by defining a hazard with the distribution of risk factors conditional on genotype modeled as a separate factor, or,

$$\mu(t \mid g) = \int \mu(t \mid \underset{\sim}{x}) \operatorname{Prob}(\underset{\sim}{x} \mid g)\, d\underset{\sim}{x} \quad . \tag{13}$$

This mixed hazard can be related to multivariate trait selection. A gap exists between population models of multiple quantitative traits and identification of classical Mendelian genes (Hartl and Clark, 1989). Random genetic drift has been represented by differential equations (Kimura, 1955). An approximation (assuming Markovity) uses a diffusion process to obtain $\varphi(x,t)$, the distribution of x alleles at t. Phenotype and genotype are assumed to be Gaussian distributed with selection of one phenotype over another altering φ's moments. If z_n is the phenotypic value of the nth trait, the vector of traits $\underset{\sim}{z}$ is

$$\underset{\sim}{z} = \underset{\sim}{x} + \underset{\sim}{e} \quad , \tag{14}$$

where $\underset{\sim}{x}$ are genetic differences for N traits and $\underset{\sim}{e}$ are environmental effects. If $\underset{\sim}{P}$, $\underset{\sim}{G}$, and $\underset{\sim}{E}$ are covariance matrices for $\underset{\sim}{z}$, $\underset{\sim}{x}$, and $\underset{\sim}{e}$, then the fitness (probability of survival) is,

$$\overline{w} = \int p(\underset{\sim}{z})\, w(\underset{\sim}{z})\, d\underset{\sim}{z} \, . \tag{15}$$

The mean phenotype after selection (environmental effect mean is assumed 0.0) is,

$$\overline{\underset{\sim}{z}}' = \overline{w}^{-1} \int \underset{\sim}{x}\, g(\underset{\sim}{x})\, \tilde{w}(\underset{\sim}{x})\, d\underset{\sim}{x} \, , \tag{16}$$

where g(x) is the distribution of genetic effects and $\tilde{w}(\underset{\sim}{x})$ is the mean fitness of genotype $\underset{\sim}{x}$. The change in the mean genotype is

$$\Delta \overline{\underset{\sim}{z}} = \overline{\underset{\sim}{z}}' - \overline{\underset{\sim}{z}} \, . \tag{17}$$

Applying the del(•) operator to the mean fitness function produces a gradient,

$$\nabla \ln(\overline{w}) = \underset{\sim}{P}^{-1} \underset{\sim}{S} \, , \tag{18a}$$

$$= \underset{\sim}{G}^{-1} \Delta \overline{\underset{\sim}{z}} \, , \tag{18b}$$

$$= \underset{\sim}{G}^{-1} (\overline{\underset{\sim}{z}}' - \overline{\underset{\sim}{z}}) \, , \tag{18c}$$

where $\underset{\sim}{S}$ is the vector of selection differentials,

$$\underset{\sim}{S} = \bar{w}^{-1} \int \underset{\sim}{z}\, p(\underset{\sim}{z})\, w(\underset{\sim}{z})\, d\underset{\sim}{z} - \bar{\underset{\sim}{z}}\,, \qquad (19)$$

or,

$$\Delta \bar{\underset{\sim}{z}} = \underset{\sim}{G}\, \underset{\sim}{P}^{-1}\, \underset{\sim}{S}\,. \qquad (20a)$$

In (20a), $\Delta \bar{\underset{\sim}{z}}$ are average phenotypic changes, $\underset{\sim}{S}$ are selection differentials, and $\underset{\sim}{G}\, \underset{\sim}{P}^{-1}$ is the fraction of phenotypic variation that is additive genetic variance. Changes in $\bar{\underset{\sim}{z}}$ for "weak" selection are

$$\Delta \bar{\underset{\sim}{z}} = \underset{\sim}{G} \nabla \ln \bar{w}\ , \qquad (20b)$$

where $\nabla l n\, \bar{w} = \underset{\sim}{P}^{-1}\, \underset{\sim}{S}$ (see equation 18) (Hartl and Clark, 1989). To relate this to the state-space model, we substitute equation (3) into equation (6):

$$\Delta \underset{\sim}{x}_t = -\underset{\sim}{V}^*(\underset{\sim}{\beta}_t + \underset{\sim}{B}_t\, \bar{\underset{\sim}{x}}_t) \qquad (21a)$$

$$= \underset{\sim}{V}_t^*\, \underset{\sim}{B}_t(\underset{\sim}{x}_t^0 - \bar{\underset{\sim}{x}}_t)\,. \qquad (21b)$$

where $\underset{\sim}{V}_t^*$ corresponds to $\underset{\sim}{G}\, \underset{\sim}{P}^{-1}$, $\underset{\sim}{B}_t$ is a quadratic matrix (as is $\underset{\sim}{P}^{-1}$); and $x^0_t - \bar{\underset{\sim}{x}}_t$ is the vector of deviations from optimal values (corresponding to $\underset{\sim}{S}$). Thus, the diffusion model of quantitative traits with selection for fitness is related to the state-space model—except the force of selection in the state-space model has a specific form (quadratic); and deterministic and stochastic age-variable components of change in phenotypic variation are explicit. In equation (1), fixed components represent $\underset{\sim}{G}$ variation. Time-varying components generalize $\underset{\sim}{P}$ to $\underset{\sim}{P}(t)$ where time dependency is multivariate. The state-space model allows $\underset{\sim}{x}$ to vary with time; that is, the age variation of genotypic risk is a mix of risk-factor-specific hazards, multiplied by the probability of having a given risk-factor value, given a genetic factor (g). In the state-space model, Prob($\underset{\sim}{x}\,/g$) in (13) is replaced by a multivariate process for $\underset{\sim}{x}_{it}$, with genetic variance represented by fixed effects (for example, $\underset{\sim}{u}_{0i}$; $\underset{\sim}{\alpha}_1$). The interaction of G with E is represented by exogenous processes, $\underset{\sim}{y}_{it}$ and interactions with fixed effects. The identifiability of components of the state-space model depends on the length of follow-up and measurement density. In the hazard model, in addition to risk conditional on $\underset{\sim}{x}_{it}$, θ represents the average age effects of unobserved factors on $\underset{\sim}{x}_{it}$ with $\mu_{0t}(=\mu_0 \cdot e^{\theta t})$ representing senescence. Genetic effects are represented by the dependence of mortality on $\underset{\sim}{u}_{0i}$ or $\underset{\sim}{\alpha}_1$ in the dynamics, for example, for a one-step forecast, t to t+l,

$$\mu_{t+1}(\underset{\sim}{x}_{i,t+1}) = \mu_{t+1}(\underset{\sim}{u}_{0i} + \underset{\sim}{\alpha}_1\, t + \underset{\sim}{\alpha}_2\, \underset{\sim}{x}_{it})\,. \qquad (22)$$

The interaction of dynamics and mortality leads to multistep forecast equations like (5) through (9).

Examples of Genetic Analysis in Studying Chronic Disease and Aging

As indicated above, the effects of genetic differences are not directly observed in human populations but must be inferred. Examples of genetic analysis in studying chronic disease and aging are Knudson's (1971) work on the effects of genes on the cancer retinoblastoma; other researchers have shown that the risk of early breast cancer is strongly related to family pedigree: (the relative risk is 50 to 1 for a woman whose mother and a sister have had early breast cancer); but late-onset breast cancer bears no strong relation to family history (Lynch and Watson, 1990; Mettlin et al., 1990; Roseman et al., 1990).

Genetic analyses are often not adjusted for cohort, or heterogeneity, effects. Failure to recognize cohort trends can produce biased estimates— and compromise genetic inferences. For example, U.S. lung cancer mortality has been increasing over birth cohorts, which makes cross-sectional estimates of *m* too large.

Experimental studies can identify genetic factors. For example, Farrar et al.'s (1990) work on the effect of aluminum on Alzheimer's risk suggests that a genetic defect in the blood-brain barrier allowed, experimentally, gallium (an element chemically similar to aluminum) transfer in both Down's and Alzheimer's patients. Head injuries, another Alzheimer's risk factor, might also damage the blood-brain barrier (Graves et al., 1990).

Genetic heterogeneity at ages 90 or 100 and more is not much different from that for persons, say, age 50 (Thieszen et al., 1990; Beregi et al., 1991; Takata et al., 1987; Marriotti et al., 1992).[13] Models in which senescence is controlled by a few genes regulating the number of cell replications such as the Hayflick limit are too simple to explain longevity, though some believe genes controlling growth factors regulating cell death may be significant, (see Hayflick and Moorhead, 1961; Finch, 1990; Cristofalo et al., 1989).

Studies suggest that genetic diseases are important at early ages. For example, Reed (1990) found that the concordance rate for CVD risk factors decreased with age. As discussed above, genetically determined breast cancer is expressed early. And, most genetically determined lung cancer is manifest before age 70 (Sellers et al., 1990).

[13] Only a few human leukocyte antigen markers for autoimmune disorders were depleted in centenarians (Takata et al., 1987), although Glueck et al. (1976) suggest that genetic traits controlling lipid profiles confer longevity. HLA heterogeneity may be a marker of longevity (Gerkins et al., 1974). Mooradian and Wong (1991a,b) suggest that strict genetic control of senescence is unlikely; that is, a polygenic determination of multiple dimensions of survival is more probable because of the different ages at which diseases operate, producing different effects over the life span.

We need new multivariate-process models to detect the stochastic generation of mutations in DNA with age over the life span and to distinguish those from genetic endowment. If free-radical damage to DNA accumulates with age, the fidelity of DNA replication is affected (Cutler, 1991). This could be modeled as a stochastic process with a diffuse effect on genes emerging at late ages, (such as plasma cell abnormalities of unknown significance; Alexanian et al., 1988). Free-radical damage at advanced ages may affect mitochondrial, DNA, rather than nuclear DNA, thus affecting energy production. Thus, DNA changes may be involved in aging—but not necessarily through inheritance; the effects could be similar to neoplasia, in which fidelity of function is lost as DNA errors accumulate.

CONCLUSION

Because of the very high costs of caring for people with health impairments, models that demonstrate the potential impact of various health policies and that accurately project changes in disability rates are extremely valuable tools for policy makers.

In this chapter we have discussed the tools of medical demography and the areas of research to which they may be applied. Many of these tools require the development of biologically detailed models of changes in the health of populations. We have discussed the factors affecting the use of such models to describe changes in health between two elderly populations at a given point in time and changes in the health of a given population as they age through time. We need to understand better the processes related to age that affect health, and we need to learn how to exploit longitudinal and demographic data to describe those effects. Because biomedical science is advancing so rapidly, so must the evolution of models. We can accomplish this evolution by using a general state-space model that can be elaborated as more refined data become available.

Medical demography is conceptually and procedurally distinct from the epidemiology of chronic disease. The epidemiologist attempts to discern causal relations between risk factors and disease endpoints, often using general statistical models to test the significance of relations. To investigate causality requires experimental designs and randomized trials. The medical demographer uses estimates of epidemiological and clinical relations in population models to asses their implications, with and without interventions, for both current and future populations. However, in performing those tasks, the validity of the basic epidemiological relations are tested at the population level, and the result may be estimates of population effects with implications for the interpretation of epidemiological data. In addition, it may be necessary to estimate different types of models of complex health processes whose parameters may require evaluation in multiple data sets. Finally, the biostatistician is often interested in assessing the effects of clinical interventions—usually for relatively short periods of time. Thus, many biostatistical methods do not deal with the long-term age changes that are the focus of medical demography.

Of greater importance to the medical demographer than to epidemiologists or biostatisticians is the effect of functional change in the population. Analysis of such changes involves endpoints that are difficult to measure and that evolve over long periods of time. The medical demographer is also more concerned with cohort and life-cycle effects and with the use of longitudinal survey data to assess changes in health over time without significant population bias. Designs of longitudinal surveys appropriate for assessing complex changes in the health of the elderly will require methodological research. A state-space model such as we have detailed here may aid this development. The effects of length of time between measurements, and the effects of the detail of measurement, can be examined by considering changes in θ over design parameters.

Thus, medical demography is an endeavor to synthesize scientific insights from multiple disciplines to explain and forecast change in the health outcomes of populations that are attributable to age. It thus relies on multivariate, stochastic models to represent the interactions of disease, disability, and mortality as they change over time, and as they affect people as people age. Recent evidence indicates that these dynamics are more complex than once supposed and that simple hazards do not describe them. This finding is not surprising. These dynamics are the consequences of changes in the health of individuals as they age, related to declines in mortality and to increases in life expectancy, which permit manifestation of nonlinear behavior. Clearly, what is called for is much more research on these processes before interventions can be carefully coordinated with simultaneous changes in health.

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8

Socioeconomic Differences in Adult Mortality and Health Status

Samuel H. Preston and Paul Taubman

INTRODUCTION

In most populations, people with more schooling, higher income, and more prestigious occupations enjoy better health and longer lives. It would be surprising if this were not so because healthiness and longevity are nearly universal goals, and higher-ranking social groups have, on average, more resources with which to pursue those goals.

Although the direction of relations between health and socioeconomic attributes accords with common sense, the magnitude of these relations has been the object of intense scientific scrutiny. There appear to be three major reasons for this attention. First and foremost, societies are concerned not only with the average levels of welfare-related variables such as income and health but also with their distribution among social groups. Although views may differ about the desirable or appropriate extent of inequality, few would argue that inequality is irrelevant or outside the suitable domain of government action. Second, the widely available data on socioeconomic differentials in mortality and health sometimes provide important clues regarding the etiology of particular diseases, as in the case of polio, breast and cervical cancer, and coronary heart disease. Third, evidence about

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socioeconomic differentials helps to identify high-risk groups to which health programs can be most efficiently directed.

This chapter reviews recent evidence about the extent and sources of socioeconomic differences in mortality and health among older persons in the United States, with some reference to other countries. That is, the principal focus is on the first concern addressed above, rather than on the use of socioeconomic information for epidemiologic or programmatic purposes. With the proliferation of well-designed epidemiologic studies of precisely measured risk factors, there is less and less need to use the rather crude information provided by socioeconomic variables to identify etiologic factors in disease. Indeed, some of the early efforts to do so yielded interpretations that proved to be seriously misleading (e.g., the supposed link between highly demanding intellectual activities and coronary heart disease in Ryle and Russell, 1949). And socioeconomic groups are also a rather amorphous basis for designing health interventions, for which geographic or organizational detail is often more salient.

Even if the focus is on inequality, we have to justify a concern with inequality among groups arrayed on variables such as education or income. Other measures of inequality, such as the variance in ages at death, are also available and make no reference to such variables (Illsley and LeGrand, 1987). The concern with *structured* inequality—that associated with an individual's socioeconomic position—appears to derive from a belief that society at large has some influence on the structure of social positions and on who occupies them. If inequalities in the outcomes associated with that structure are too great, a sense of collective responsibility can generate efforts to reduce inequality. No similar reaction would be generated if the principal source of variation in mortality were, say, the ownership of a motorcycle or left-handedness.

Unfortunately, the measurement of inequality in health and mortality is not straightforward. The principal issue is not choosing one of the many inequality measures available but rather deciding, as Sheps (1958) put it, whether to count the living or the dead. In comparing the extent of inequality across times and places, this distinction is often critical. For example, if the probability of death for manual workers declines from .10 to .05, and for nonmanual workers from .05 to .02, then the ratio of manual to nonmanual death probabilities has risen but the ratio of manual to nonmanual survival probabilities has also risen. Which group has become relatively worse off after the change? This question is hardly academic, since these kinds of changes are widely observed. Hansluwka (1986) shows, for example, that Gini coefficients of social class inequality in infant mortality in England and Wales rose between 1921 and 1970-1972 when expressed in terms of mortality, but fell when expressed in terms of survivorship. We believe that differences in age-specific survivorship—the desideratum—are more salient (and certainly more analogous to inequalities in other desiderata such as income and nutrition). Nevertheless, we must conduct this review by reference mainly to negative indicators such as mortality and disability because that is the convention in nearly all writings on the subject. It is worth noting that neither relative nor absolute differences in survival can be recovered from estimates of relative risk; it is the *difference* between mortality rates, not their ratio, that determines the *ratio* of survival rates.[1]

SOCIOECONOMIC MEASURES

The principal indicators of one's position in contemporary society are income, occupation, and educational attainment. These are closely related to Weber's (1946) more abstract conception of social position in terms of the three dimensions of class (a primarily economic concept), status (associated with occupational prestige), and power (a function of one's ability to mobilize resources on one's behalf). Liberatos et al. (1988) provide a useful discussion of how the three indicators have been used in epidemiologic studies. They find that epidemiologists are much more likely to use education as a "control variable" than either income or occupation. The disadvantages of occupation are that many people do not have one (e.g., retired people, housewives) and that one's occupation—and labor force participation—may be determined by one's health status as an adult (Fox et al., 1985). Such reverse causation creates problems of interpretation; in particular, it is not sensible to treat one variable as dependent and the other as independent. This problem is even more serious for income, since disabilities can affect not only occupation but also hours of work. Unlike occupation, education is measured on an interval scale. Unlike income, it is not derived from multiple sources with very different implications (or, in the case of family income, from multiple individuals). Because of its stability,

[1] The probability of survival from age x to $x+n$ for group i is

$$ {}_nP_x^i = e^{-\int_x^{x+n} \mu_i(a)\,da}, $$

where $\mu_i(a)$ = death rate for group i at age a. Therefore, the log of the ratio

$$ {}_nP_x^1 / {}_nP_x^2 $$

is equal to

$$ \int_x^{x+n} [\mu_2(a) - \mu_1(a)]\,da, $$

the cumulative absolute difference in death rates between groups 1 and 2.

educational attainment is an especially valuable measure among those over age 65. However, even the amount of education one obtains may be influenced by a long-lasting disability, which can affect subsequent mortality and morbidity. So the use of education does not resolve all problems of reverse causation.

Educational attainment has also become the measure of choice among demographers and statisticians who study socioeconomic differences in mortality (e.g., Kitagawa and Hauser, 1973). But we must be aware that although they are correlated with one another, education, income, and occupation tap different features of socioeconomic position that are relevant to health. Most directly, income indicates the amount of resources available to purchase health-related goods and services, including medical services themselves. It may also reflect on-the-job health risks. Occupation is associated with a variety of physical and psychosocial features of the workplace. Educational attainment is associated with the availability of information and with cognitive skills. Perhaps by virtue of these connections, there is evidence that education is more closely associated with health behaviors and with cardiovascular risk factors than are the other two variables. Winkleby et al. (1992) show that educational attainment is the only socioeconomic variable having a significant relationship to cigarette smoking, blood pressure (women only), and high-density lipoprotein (HDL) cholesterol in a cross-sectional study of 2,380 participants in the Stanford Five-City Project.[2] This may be the only study of their joint effects.

RECENT EVIDENCE ON THE EXTENT OF SOCIOECONOMIC DIFFERENCES IN MORTALITY AND HEALTH STATUS

After being for many years one of the industrialized countries with the poorest data on socioeconomic differences in mortality, the United States now has two large and high-quality data sources: the National Health and Nutrition Examination Survey (NHANES), which includes the National Health Epidemiologic Follow-up Study (NHEFS), and the National Longitudinal Mortality Study (NLMS). Both are probability samples of the entire U.S. noninstitutionalized population that have been followed forward from initial interviews. Both have overall mortality levels close to, but slightly better than, national vital statistics levels; the lower mortality level is likely to result primarily from their initial restriction to noninstitutionalized persons.

NHEFS consists of 14,407 persons aged 25-74 when surveyed in 1971-

[2] The income measure used was gross family income, unadjusted for family size or number of earners. The occupational variable was created by imposing an arbitrary cardinal scale on ordinal categories. It is possible that more refined measures of these variables would have performed better.

1975 who were followed to 1982-1984. Feldman et al. (1989) have described educational differentials in mortality in this data set and compared them to the 1960 differentials based on a census-vital statistics matching study (Kitagawa and Hauser, 1973). Figure 8-1 displays the magnitude of educational differentials for older white persons, as well as trends in them, between the two observations.

It is clear that except for men aged 75-84 in 1960, those with more education have lower death rates for all ages and both sexes in each year. It is also clear that apart from men aged 65-74 with 0-7 years of schooling, death rates declined over the period of observation for each age-sex-education category. What is perhaps most striking about the figure is the widening of educational differences in mortality for males between these dates.[3] Such a tendency was earlier described by Taubman and Rosen (1979) based on a 1973 Current Population Survey matched to Social Security death records through 1976. No widening of differentials is evident for females, whose declines are essentially equiproportionate. After being much smaller, male differentials (as indicated by the educational range in the log of death rates) are roughly as large as female differentials by 1971-1984. A final tendency evident in the figure is a narrowing of the range of educational differences in mortality as age advances, particularly after account is taken of the expansion of education categories for the two oldest age groups. This observation is consistent with much observed human experience; in comparing the typical age pattern of mortality of a high-mortality population to that of a low-mortality population, proportionate differences narrow above age 40 or so as age advances (Coale and Demeny, 1982).

Table 8-1 shows that much of the widening of educational differentials for white males aged 65-84 is attributable to a massive change in the educational distribution of heart disease mortality. Heart disease death rates declined by 57 percent for college-educated men and by 5 percent for men with less than 8 years of schooling. With 1960 education differences in heart disease mortality substituted for those in 1971-1984, the ratio of death rates from all causes for the two education groups would have been 1.20 in 1971-1984 instead of its actual value of 1.73.

The second major source of data on socioeconomic differences in mortality is the NLMS. The study population consists of 1,281,475 people who were included in various Current Population Surveys of the Census Bureau

[3] Some uncertainty about these trends is introduced by the high nonmatch rate in the census-vital statistics matching study: 18 percent of white male decedents aged 65+ were not matched to 1960 census records, and estimates of educational attainment for these individuals were based on a sample with a 25 percent nonresponse rate on the education question (Kitagawa and Hauser, 1973:189,193). These figures were no worse for men than for women, however.

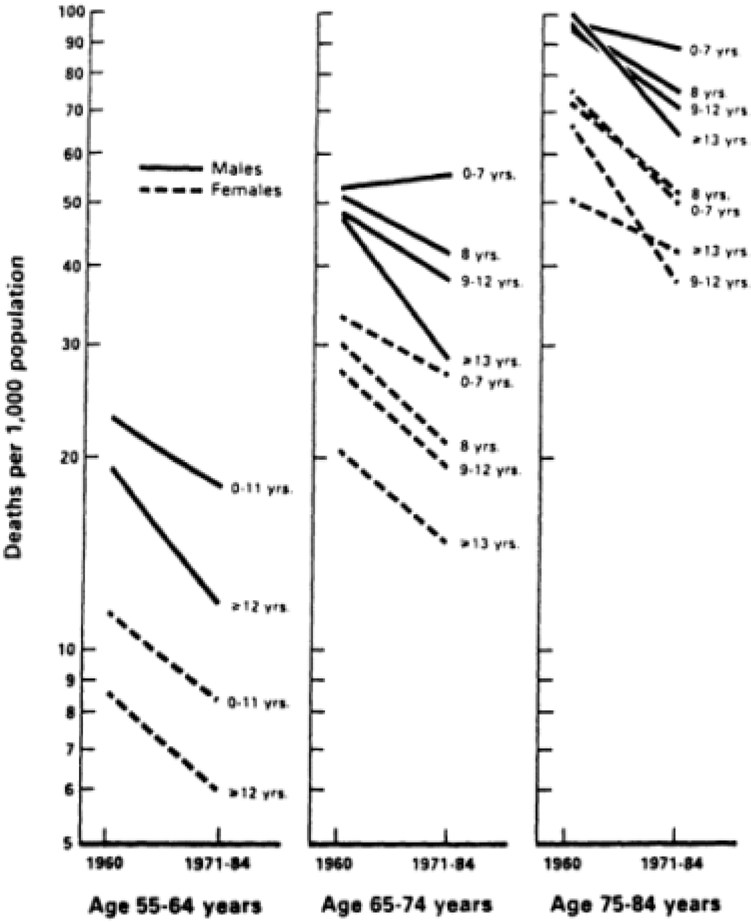

Figure 8-1
Estimated annual death rates by age at death, sex, and educational attainment among white persons aged 55-84 years, United States, 1960 and 1971-1984.
SOURCE: Feldman et al. (1989). Reprinted with permission.

from 1973-1985, except for 10 percent of the participants who were drawn from the 1980 U.S. census of population. The cohorts were followed forward for a maximum of 7 years or to January 1, 1986, whichever came first (Rogot et al., 1992b:Table A). Records for these individuals were matched to the National Death Index beginning in 1979, yielding a total of 44,828 deaths. This study thus provides a firm basis for inferring the magnitude of socioeconomic differences in mortality.

TABLE 8-1 Annual Death Rates per 1,000 Population, by Cause of Death a, Sex, and Educational Attainment, Among White Persons Aged 65-84 Years, United States, 1960 and 1971-1984

Cause of Death and Years of School completed	Males		Females	
	1960	1971-1984	1960	1971-1984
	Rate	Rate (SE)	Rate	Rate (SE)
All causes				
0-7	66.2	66.8 (4.1)	48.5	35.7 (3.0)
8	65.5	53.1 (4.0)	45.4	31.8 (2.8)
9-12	64.9	47.0 (3.2)	41.4	24.4 (1.9)
13+	64.2	38.7 (4.1)	30.8	23.5 (2.8)
Heart disease				
0-7	30.6	29.2 (2.7)	22.9	14.0 (1.9)
8	31.5	27.0 (2.8)	20.9	12.2 (1.8)
9-12	31.2	18.6 (2.0)	18.6	9.9 (1.2)
13+	30.3	13.0 (2.4)	12.6	7.5 (1.6)
Other than heart disease				
0-7	35.6	35.8 (3.0)	25.6	20.7 (2.3)
8	34.0	25.2 (2.7)	24.5	18.3 (2.2)
9-12	33.6	27.9 (2.5)	22.8	13.2 (1.4)
13+	33.9	25.2 (3.3)	18.3	15.7 (2.3)

[a] Cause of death is missing for 2 percent of deaths among males and 4 percent of deaths among females in 1971-1984. These deaths were included in calculating death rates for all causes, but excluded for cause-specific death rates.

NOTE: SE = standard error.

SOURCE: Feldman et al. (1989). Reprinted with permission.

Table 8-2 presents educational differences in mortality from this study in the form of ratios of actual to expected deaths, where expected deaths are developed by applying the average probability of dying in a particular sex, race, and 5-year age group to each individual's years of exposure. Because the study is much larger than NHEFS, estimates can be made for blacks and the very old (85+). It is clear that educational differences in mortality among blacks are similar to those among whites. However, the lowest educational category (0-4 years of schooling) suffers less disadvantage among blacks, perhaps because it is a less precise marker of physical and mental handicaps in a population where restricted education is as much a product of social forces as of personal attributes. Likewise, blacks who attend college—a highly selective group—have relative mortality ratios lower than their white counterparts. Thus, the black data reveal a similar gradient (slope of the education/mortality relation) to that of whites, but one that

TABLE 8-2 Ratio, Actual to Expected Deaths by Age and Education in the National Longitudinal Mortality Study

Education (years)	White Males	White Females	Black Males	Black Females
Age 25-64				
0-4	119	143	115	113
5-7	134	127	113	119
8	121	120	105	105
9-11	124	109	113	116
12	98	94	89	90
13-15	92	94	86	72
16	70	78	60	47
17+	58	83	51	63
Total	100	100	100	100
Age 65+				
0-4	106	110	98	97
5-7	106	103	101	110
8	108	104	123	108
9-11	105	99	97	104
12	94	100	102	83
13-15	94	91		
16	85	88	68	75
17+	75	76		
Total	100	100	100	100
Age 85+				
0-4	107	110	102	93
5-7	93	101		115
8	103	101		
9-11	107	95		
12	100	96	98	97
13-15	105	95		
16	93			
17+	82	105		
Total	100	100	100	100

NOTE: Categories with 40 or fewer expected deaths have been combined with adjacent categories.

SOURCE: Derived from Rogot et al. (1992a:Table 6).

begins and ends at a lower level. Unfortunately, the manner in which source data are presented makes it impossible to compare directly the mortality rates of blacks and whites having the same educational attainment.

Table 8-2 reveals that educational differences in mortality are virtually absent among the population aged 85 and older. This tendency is consistent with narrowing differentials with age revealed by NHEFS for younger ages. White females aged 85+ do show small but persistent differentials in the expected direction up to the level of college graduates. On the other hand, white males aged 65+ in 1960 also showed no educational differentials in mortality, but those differentials have emerged subsequently in this age span. It is intriguing that the "cohort" aged 65+ in 1960 is much the same as the cohort aged 85+ in the early 1980s, which suggests that cohort approaches to studying socioeconomic differences may have some merit.

The most disturbing feature of Table 8-2 is that education differences in mortality are much smaller than in NHEFS. For example, in the NHEFS the ratio of death rates of white males aged 75-84 for those with less than 8 years of schooling to those with some college is 1.95 (Table 8-1), whereas in the NLMS the ratio of actual/expected death ratios for the two groups is only 1.17 (not shown). There is no apparent reason why these ratios, and those for other age-sex groups, would be so different. NHEFS observations are centered around 1978 and NLMS ratios around 1983, but it is surely unlikely that differentials would have widened and then contracted so dramatically. Since NLMS has roughly 70 times the number of person-years of exposure as NHEFS, it seems to provide a firmer foundation for assessing educational differentials.

Evidence of the plausibility of NLMS educational differentials is their consistency with international patterns. Valkonen (1987) has provided a masterful review of socioeconomic differences in mortality in Europe. He assembles data from different countries on educational differentials in mortality for men and women age 35-54 during 1976-1980. These are also based on census samples followed forward into death records. We have plotted rates from NLMS for whites in the United States based on Valkonen's figures (Figures 8-2 and 8-3). Although the actual rates are not recoverable from NLMS publications, the ratio of deaths to expected deaths is a multiplicative transformation of the death rates themselves. Since the figures are on a log-linear scale, their slope is invariant to a multiplicative transformation. We have simply chosen a "level" for the U.S. ratios that presents them in a convenient plotting range.[4]

It is clear that U.S. patterns are congruent with those in Europe for both

[4] In particular, we have multiplied the ratios of actual to expected deaths, assembled from Rogot et al. (1992a:Table 6), by a factor of 0.006 for males and 0.003 for females.

males and females. As in Europe, the educational differentials in the prime working ages are much sharper for males than for females (see Valkonen, 1989, for a more rigorous confirmation). An obvious explanation of this sex difference, which may not be correct, is that personal (and family) economic standing is more closely associated with men's than with women's education. It is also possible that health-related behaviors are more closely associated with men's than with women's education.

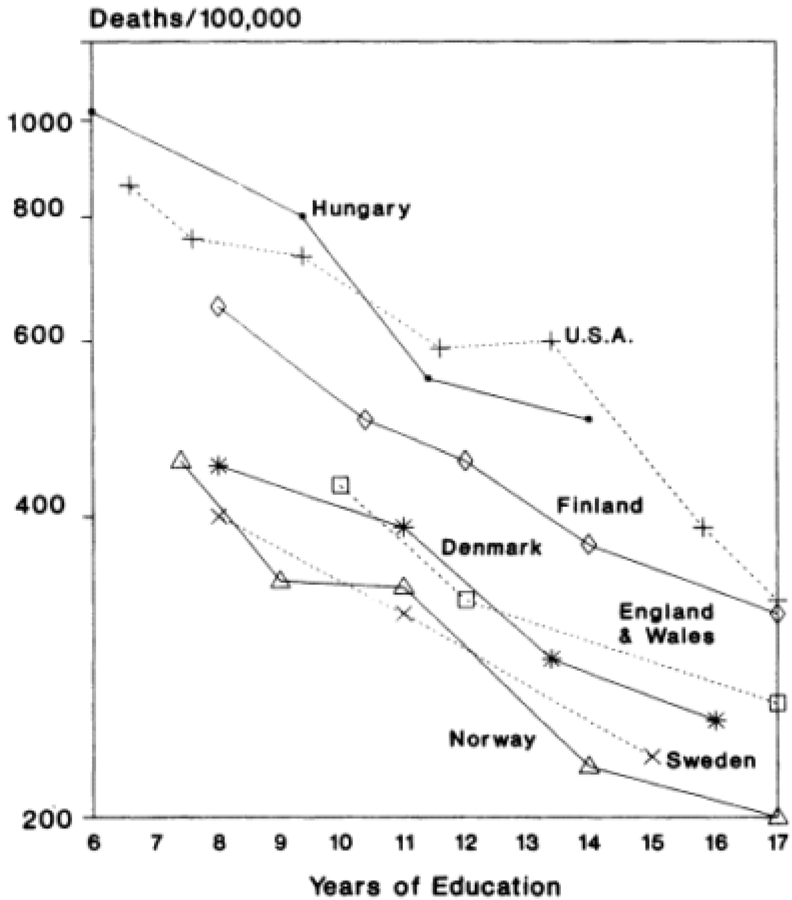

Figure 8-2
Age-standardized mortality (per 100,000) from all causes of death by years of education and country, males aged 35-54, 1976-1980, log scale.
NOTE: U.S. data are for white persons during 1979-1986.
SOURCES: Valkonen (1987); Rogot et al. (1992a).

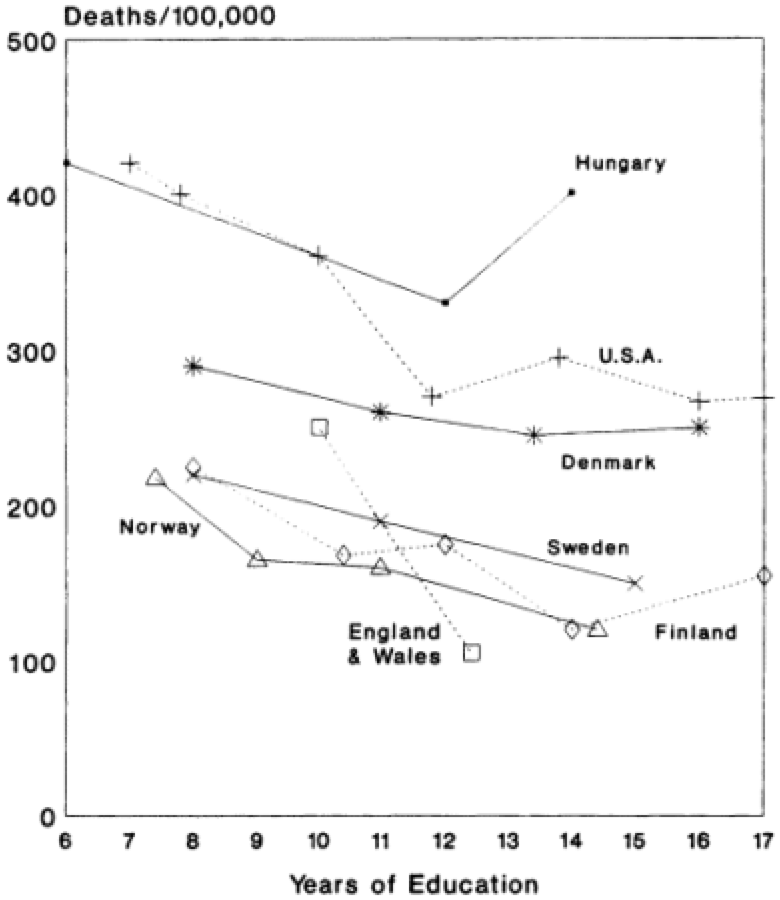

Figure 8-3
Age-standardized mortality (per 100,000) from all causes of death by years of education and country, females aged 35-54, 1976-1980, log scale.
SOURCES: Valkonen (1987); Rogot et al. (1992a).

Educational differences in mortality have tended to widen in Europe, as they have probably done in the United States as well (Valkonen, 1987, 1992). A widening of socioeconomic differences in England and Wales (measured principally by occupation rather than by income) has evoked a storm of controversy, in part because the National Health Service instituted after World War II was expected by some to mute class differences in health. Major contributions include the Black Report (Townsend and Davidson, 1982), Wilkinson (1986), Pamuk (1985), Marmot and McDowall (1986), Fox et al. (1985), and West (1991).

Space does not permit an adequate review of the causes of death principally responsible for educational differentials in mortality in the United States. The issue is not which cause of death exhibits the largest differentials but which cause contributes the most to the education differential for all causes combined. Table 8-3 uses NLMS data to begin addressing this question. For a particular cause of death category, it sets observed equal to expected deaths for all education groups and shows the impact of such equalization on differentials from all causes combined. Lung cancer deaths clearly contribute a minor amount to overall differentials; that is, setting observed equal to expected deaths from lung cancer for each group would lead to relatively little contraction in educational differentials from all causes combined. The same is true for "all other cancers"; in fact, these cancers

TABLE 8-3 Ratios of Actual to Expected Deaths by Educational Attainment, With and Without Differentials for Particular Causes of Death: United States, 1979-1986

Deaths and Years of Schooling	Cause of Death for Which Actual Deaths Are Set Equal to Expected			
	None	Lung Cancer	Other Cancers	Heart Disease
White Males, 25-64				
0-8	125	121	122	116
9-11	124	119	122	117
12	98	99	98	99
13+	76	80	77	84
White Males, 65+				
0-8	107	108	106	104
9-11	105	105	105	103
12	94	95	94	95
13+	86	88	88	94
White Females, 25-64				
0-8	125	124	132	112
9-11	109	107	109	103
12	94	94	96	96
13+	88	89	85	98
White Females, 65+				
0-8	105	105	105	101
9-11	99	99	100	99
12	100	100	100	102
13+	88	89	88	95

SOURCE: Compiled from Rogot et al. (1992a) have attenuated differentials for white women aged 25-64 and are the principal reason why observed male differentials are sharper than observed female differentials in this age range. Differences between the sexes in educational differentials in this age range are negligible after the impact of "other cancers" is eliminated. A higher death rate from breast cancer among better-educated women, perhaps related to childbearing patterns, is the principal source of this countervailing pattern.

The story is different for heart disease. If educational differentials in heart disease mortality were eliminated, the excess mortality of those with 0-8 years of schooling, relative to those with some college, would be reduced by 41 percent for males aged 25-64, 57 percent for males aged 65+, 66 percent for females aged 25-64, and 67 percent for females aged 65+. For three of the four groups, the majority of educational differences in mortality are attributable to differentials in heart disease.

The NLMS has also yielded information on differences in mortality by employment status (Sorlie and Rogot, 1990), occupation, and family income (Rogot et al., 1992a). Sorlie and Rogot (1990) show that employed persons have mortality that is much lower than average, even at ages above 65, and that those classified as unable to work have mortality rates two to seven times higher than average. By synthesizing age-specific death rates in particular socioeconomic categories, Rogot et al. (1992a) calculate life-table values for persons with different characteristics. Life expectancies at age 25 differ by 10.0 years between white men in the lowest ($5,000 per year in 1980 dollars) and the highest (³$50,000 per year) family income categories, though as noted earlier this may occur in part because sicker people earn less. The difference for white women is only 4.3 years, another indication of smaller class differences among women. Occupational differences in mortality in the NLMS have not been analyzed. Tabulations appearing in the NLMS sourcebook show the predictable gradient for white men (professional-technical mortality is 22 percent below average, laborers are 26 percent above average at ages 25-64) and a weak and irregular gradient for employed women (Rogot et al., 1992b:336-337).

The most authoritative source of national data on socioeconomic differences in health status is the Health Interview Survey, a probability sample of the civilian noninstitutionalized population. Table 8-4 presents the prevalence of activity limitations and of persons in poor or fair health in the 1989 survey, which contained data on 122,310 persons. No distinction by sex is possible, but sex differences are relatively small once age and education are controlled (House et al., 1990).

It is clear that educational differentials in disability and ill health are extraordinarily large and that by middle age their prevalence is already very high among the poorly educated. At age 45-54, more than a third of people with fewer than 8 years of schooling are in "fair" or "poor" health, com pared to less than 5 percent of those who finished college. More than a third of the poorly educated are also limited in their major activity because of a chronic condition, compared to 10 percent of those who completed college. These differentials dwarf those pertaining to mortality. As a result, people with low levels of schooling spend many more years with an activity limitation or poor health than do people with more schooling, though this may be related to the type of work or the incentives associated with disability. House et al. (1990) point out that Fries' notion of a "compression of morbidity" at the very end of a long life is much closer to being realized for the well educated than for the poorly educated. Whereas Kadushin (1964) suggested that people in lower socioeconomic groups may simply *feel* sicker, this position has not been validated (Conover, 1973; Mechanic, 1978). Blaxter (1989) reviews European evidence and finds that unskilled occupational groups have a nearly universal disadvantage on measures of health status.

TABLE 8-4 Percentage of Persons With Activity Limitation Due to Chronic Conditions and of Persons in Fair or Poor Health: United States, 1989

	Years of Schooling							
Age (years)	All	<4	4-7	8-11	12	13-15	16	17+
Persons with limitation in activity due to chronic conditions								
25-34	8.0	27.4	9.6	13.5	8.2	7.5	4.3	4.8
35-44	12.3	30.1	22.1	21.8	12.3	11.9	8.6	7.4
45-54	17.1	41.3	35.1	27.3	15.3	15.4	10.0	10.6
55-64	27.9	49.4	46.7	38.5	23.8	24.0	17.1	17.6
65+	38.3	58.6	49.6	40.9	33.7	34.0	29.2	33.1
Persons in fair or poor health								
25-34	5.1	14.5	12.2	12.6	5.4	3.7	1.6	1.6
35-44	7.9	22.4	21.7	21.0	8.5	6.2	2.9	2.1
45-54	12.5	35.1	38.6	24.1	11.6	7.4	4.3	4.1
55-64	20.3	48.5	47.1	31.9	15.3	13.9	7.7	6.5
65+	28.5	53.3	43.2	33.3	23.6	19.8	15.7	16.3

SOURCE: United States National Center for Health Statistics (1991:16,22)

Table 8-5 identifies some of the major chronic conditions for which differences in prevalence among education groups are largest. As with mortality differentials, morbidity differentials contract as age advances beyond 55 or 65. House et al. (1990) estimate regression models predicting the number of chronic conditions, an index of functional status, and an index of limitations of daily activity as functions of age and education.

TABLE 8-5 Prevalence of Selected Chronic Conditions (per 1,000 persons) by Education: United States, 1989

	Under 65		65 Years and Older	
Condition	Less than High School Education	High School and Above	Less than High School Education	High School and Above
Arthritis	138.8	67.4	518.7	452.6
Hearing impairment	86.4	49.7	312.3	266.6
Diabetes	37.0	14.8	99.8	76.7
Heart disease	71.6	44.1	299.5	264.3
Hypertension	128.8	67.5	397.9	370.3
Emphysema	14.4	2.4	45.2	27.5
Deformity or impairment of back	79.6	64.1	95.3	73.5
Frequent indigestion	35.7	17.3	54.1	25.8

SOURCE: National Center for Health Statistics (1991:Table 17).

They show that interactions between age and education are significant for all three dependent variables.

National Health Interview Survey data also describe other differences in health status among educational groups. Table 8-6 summarizes some of these differences using age-adjusted measures. Years of schooling are positively associated with the incidence of acute conditions, perhaps because of differences in reporting patterns. They are negatively associated with days of restricted activity, days spent in a hospital, and number of hospital discharges. The number of annual physician contacts shows a weak positive relation to education. In view of the poor reported health of people with little schooling, the fact that they do not visit physicians more frequently than better-educated people is surprising. One might hypothesize that they are more often deterred by doctor's costs, but the relation is no different above age 65, where physicians' services are heavily subsidized, than below. Benzeval et al. (1993) show that lower occupational groups in England make more use of health services than higher groups, but that the gradient is reversed when morbidity is controlled.

SOURCES OF SOCIOECONOMIC DIFFERENTIALS IN MORTALITY AND HEALTH STATUS

In order to infer whether and how a policy to reduce socioeconomic differences should be pursued, it is obviously important to understand their sources. The factors contributing to the differences just described have

TABLE 8-6 Age-Adjusted Health Indicators by Years of Education: United States, 1989

	Years of Education						
Health Indicator	<4	4-7	8-11	12	13-15	16	17+
Annual number of days of restricted activity per person	20.5	19.4	19.4	14.5	14.3	11.0	11.3
Annual number of physician contacts per person	3.9	5.1	5.2	5.1	5.9	5.4	6.3
Annual number of short-stay hospital discharges per 100 persons	14.8	14.3	14.6	11.5	10.2	8.7	8.2
Annual number of short-stay hospital days per 100 persons	106.8	109.1	100.9	70.5	60.0	48.6	55.5
Annual number of acute conditions per 100 persons	77.0	113.2	161.9	180.5	204.6	183.2	181.6

SOURCE: National Center for Health Statistics (1991).

been studied in a number of investigations. Too often, however, the investigations pursue a kitchen-sink approach, haphazardly throwing variables into a multivariate analysis to see what happens to coefficients. It is useful to take a step back and consider several theoretical approaches or frameworks that can shed light on the causal processes involved. In this section we review the two major frameworks that have been used to investigate the processes that create differences in mortality and health status by social class and describe some of the evidence that has been developed with the aid of those frameworks.

Economic Models

The most systematic model that addresses the relevant questions is derived from economics. From an economic perspective, individuals make decisions that help to determine their healthiness or stock of health (*H*) in any time period. Death occurs when *H* falls below some critical level, *H**. Except in extreme situations such as suicide, individuals are not viewed as making direct decisions about age at death but rather decisions about investments (e.g., exercise) and consumption (e.g., tobacco) that affect *H*, and, in turn, affect age at death.

The standard economic approach to morbidity and mortality assumes that the individual maximizes a utility function, whose value depends on the amount of various items that are consumed. Some of these items are fully or partially related to health, and some have no relationship to health. In allocating resources among consumption goods, consumers are constrained by two equations. The first is a budget equation, according to which the sum of the price times the quantity of each purchase must equal a person's income, which is in turn equal to hourly earnings times hours worked plus transfers and returns from savings. The second is a "health production function." This production function shows how *H* varies with certain inputs. The main inputs in the health production function are the quantity of each health-related consumption item; the amount of medical knowledge of health care providers; the availability of medical facilities; a person's genetic endowment; and features of the environment in which one lives. Apart from the quantity of health-related items consumed, other inputs in the health production function are typically assumed to be exogenous to the individual, though perhaps subject to governmental policy. This assumption is at times questionable. For example, one can choose to live in more or less polluted areas or those with better health care facilities. The assumption that individuals maximize utility then yields predictions about how health (*H*) will respond to changes in various exogenous variables.

Given this model, the analyst attempts empirically to relate healthiness or age at death to the exogenous price and wage terms in the budget con straint and to estimate separately the health production function based on its inputs. Some attempt is made to include in the health or mortality function all the exogenous, measured variables from both the budget constraint and the production function. Relevant studies are Sickles and Yazbeck (1991), who present a dynamic version of the above model, and Rosenzweig and Schultz (1983).

A vexing statistical problem is to obtain unbiased estimates of the coefficients of these variables. For example, acute conditions can reduce current income and chronic conditions long-run income. Thus, as noted earlier, causation between health and income runs in both directions, and more complicated estimation techniques are required. In principle, it is possible to adopt statistical methods that allow the researcher to surmount these difficulties. However, the assumptions required by these methods are often heroic. Longitudinal data with frequent observation of subjects are often critically important in sorting out issues of causation.

The main virtues of the economic model are its separation of endogenous variables (the consumption of health-related goods and services) from exogenous variables and the careful distinctions drawn among types of exogenous variables. It is these latter variables for which issues of causation are most clear-cut.

Income/Wages/Education

People with higher levels of education have, in general, higher potential wages and hence higher potential income levels. They are thus able to purchase more health-enhancing goods and services, such as physicians' and hospital services (or, less directly, better health insurance to subsidize such purchases), healthier foods, larger living space, and more leisure. They are also more able to afford to live in less polluted areas with better public services.

There have been scores of studies relating personal or family income to health status (see Sickles and Taubman, 1992, for a brief review). For example, Menchik (1993) uses the longitudinal survey of older men (45-64 in 1966) to study mortality up to 1983. In a logit model predicting the odds of survival to 1983, he obtains significant effects of both household wealth in 1966 and individual permanent earnings. Unfortunately there is some attrition in the sample, which makes the sample used by Menchik slightly nonrandom. Madans et al. (1986) find that in the NHANES follow-up study, those living in poverty have higher probabilities of dying. A recent study contains more temporal detail than others and is better able to sort through problems of causation. Zick and Smith (1991) use the Panel Study of Income Dynamics data to show that recent spells of poverty (controlling changes in marital status) increased the hazard of dying for both men and women.

There is only one experimental study of the effect of income change on health status. Elesh and Lefcowitz (1977) examine the New Jersey-Pennsylvania Negative Income Tax Experiment for evidence of changes in health status and health care utilization. The experiment lasted 3 years and resulted in average increases in annual income of 18 percent for "treatment" families. The authors conclude that "no effects of any kind are observed" on health status or health care utilization. The short duration of the experiment does not permit inferences about the health consequences of more permanent income changes.

The straightforward economic predictions of the relationships among health, income, and education are sometimes termed the "deprivation" model: poor people suffer ill health and premature death because they are poor.

Prices of Health-Related Goods and Services

Prices are central to economic models. They are a possible source of socioeconomic differences in mortality for two reasons. First, although all groups face a roughly similar set of prices in market economies for doctors and medicine, about 15 percent of the population does not have any health insurance, which generally subsidizes the market price. Second, part of the cost of health care is the opportunity cost of time spent to obtain such care. This cost depends on the wage rate one could receive and the hours spent waiting for the doctor. An 8-hour wait in the emergency room can be quite costly even if valued only at the minimum wage rate. An experimental study of health insurance provisions demonstrated that lower prices for medical services (i.e., lower copayment rates) produced higher rates of physician visitation. However, there was little evidence of change in health status measures, apart from greater prescription of eyeglasses and slight reductions in blood pressure (Brook et al., 1983). England's National Health Service has not eliminated or even reduced class differences in morbidity or mortality (see the Black Report in Townsend and Davidson, 1982).

Changes in price levels can produce changes in socioeconomic differentials. In particular, the heavy subsidy of hospital services provided by Medicare (introduced in 1966) should have led to greater behavioral changes and greater improvements in health for poorer persons above age 65, who were previously unable to afford medical insurance. We have already reviewed evidence that socioeconomic differences widened rather than narrowed during this period. Such a widening occurs above age 65 for males even if NLMS data are used because the earlier study by Kitagawa and Hauser showed negligible educational differentials in mortality for this group in 1960 (Kitagawa and Hauser, 1973). Of course, a contractionary effect of

Medicare could have been obscured by other changes, such as widening differentials in cigarette smoking.

Levels of Medical Knowledge and Technique

The nature of medical knowledge and technique, in combination with patterns of access to various medical practices, affects the size of social class differentials in mortality. For example, the development of an inexpensive method for curing AIDS would undoubtedly benefit lower-status groups more than higher-status groups, since that health problem is heavily concentrated in the former.

Since the level of medical technology at a moment in time is by definition a systemic variable, it can affect the size of social class differences only if patterns of access to that technology are differentiated by class. The departures from equal access are most efficiently viewed as a function of income differences: poorer people may not be able to afford more expensive forms of treatment. Social policy may intervene to reduce differentials in access, for example, by changing the prices for medical services faced by different groups. Medicaid is one such example. But it is rare that such intervention would be completely successful in equalizing access. For example, the price cap imposed in the Medicaid program has induced two behavioral responses by physicians. Some doctors—about one-third in Pennsylvania—will not treat patients who use Medicaid insurance, whereas others give very hurried examinations to squeeze more patients through. Similar responses to publicly funded patients are reported in Britain (Benzeval et al., 1993).

A more sophisticated model would recognize that all households and people are not equally skillful in allocating scarce resources. Although some aspects of medical technology can be "delivered to" households (e.g., sewer systems), others require the active involvement of household members in their implementation. For example, improved knowledge of the etiology of infectious diseases and of the personal health measures that can prevent them is a likely source of the sharp expansion of class differentials in American child mortality between 1900 and 1930 (Ewbank and Preston, 1991). In this connection, educational attainment is often singled out as the feature that is most predictive of success in introducing health-enhancing techniques into the household (e.g. Pratt, 1971; Winkleby et al., 1990). In this more complex model, education is not related to health simply through its connection with earnings but also through its association with managerial expertise. According to this approach, medical technique interacts not only with aggregate features that affect access, but also with many household characteristics, to influence the pattern of social class differences in health status.

Personal Endowments

Adults who make decisions about health-related behaviors carry marks from the past. Not only are their educational levels essentially determined by late adolescence, but so are their physique and their exposure to infectious diseases of childhood. Studies showing a strong inverse correlation between adult height and cardiovascular disease indicate that these mechanisms may be important. So do cohort studies demonstrating that susceptibilities to certain diseases are established early in life and persist through adulthood (Elo and Preston, 1992). Failure to control these early influences on adult health can lead to misspecifications and bias. Since a poor health environment in childhood is undoubtedly associated with low levels of schooling, the direct effects of schooling on adult health status can be overestimated without proper controls on earlier experience. However, in the only individual-level multivariate study of these relations of which we are aware, Mare (1990) shows that the excess mortality of men whose fathers were in low occupational groups is eliminated when the man's years of schooling are controlled.

Other childhood endowments that are not direct manifestations of health status may also be important to adult health. These include such factors as cognitive skills and personality variables that may affect health through both income and household management. They also include a predisposition to various health habits. Waldron and Lye (1989) show that men of lower occupational status were more likely to smoke but that smoking differences by class were established before the age of labor force entrance. Subsequently, they show that high school seniors with less educated parents and lower educational aspirations were more likely to smoke cigarettes (Waldron and Lye, 1990). Failure to control these early life factors can lead to misspecification and biased estimates of coefficients on observed adult socioeconomic variables.

Other early life influences on adult mortality may be present at conception. The role of genetic variation in social class mortality differentials has been emphasized by Illsley (e.g., 1955), but there has been no convincing demonstration of the role of genetic factors in fashioning class differentials in mortality. Here, we will briefly note several studies that bear on the question. The studies rely on a model developed by Fisher (1918), in which any outcome (phenotype) depends on one's genotype and environment (everything else). In his model, many genes each have a small impact on the phenotype. The methodology used to implement the model generally relies on a comparison of identical and fraternal twins, with the two groups often distinguished by the answer to a question such as, When you were children were you as alike as two peas in a pod or of only ordinary family resemblance? (see Behrman et al., 1980). Based on a comparison with a detailed analysis of blood samples, this question classifies twins correctly in more than 95 percent of the cases in the studies discussed below.

The few available studies indicate that both genetic endowment and the early environment affect adult social class.[5] These include Behrman et al. (1980), Lykken et al. (1990), and Behrman et al. (1992). Mortality is also related to genotype and environment. Identical twins have a smaller variance in age of death than other twins, and differential smoking behavior between twins strongly affects the risk of death over a given time interval (Behrman et al., 1980; Kaprio and Koskenvero, 1990). These research traditions have developed independently of one another, and their implications for understanding social class differences in mortality are unclear.

These mechanisms are sometimes referred to as selection effects or unobserved heterogeneity: people are selected into statuses on the basis of variables whose values are often unobserved. The question of whether adult socioeconomic mortality differences in England and Wales principally reflect the operation of "selection effects" has generated a great deal of interest, including the bulk of an entire issue of *Social Science and Medicine* (Volume 32 (4), 1991). The evidence brought to bear on the issue is mainly indirect and circumstantial (e.g., patterns of mortality differentials by age and cause of death). One direct attempt to estimate an adult mortality model that includes an explicit allowance for unobserved heterogeneity uses longitudinal data from the U.S. Retirement History Survey. The authors find that coefficients on education and income are very robust to the introduction of an allowance for unobserved heterogeneity (Behrman et al., 1993).

A demonstration that socioeconomic differences in adult health were principally a reflection of socioeconomic differences in child health, operating via selection effects, would obviously not alleviate social responsibility for such differences, although it would change the age focus of social concern.

Environmental Factors

One's environment can affect one's health status independently of personal characteristics. For example, the incidence of communicable diseases in a community affects an individual's risk of contracting one. An investigation using data from the Alameda County Study finds that residents of a federally designated poverty area in Oakland had mortality rates that were 55 percent above those of residents in other areas, when age, sex, race, and

[5] The basic identifying assumption is that the expected value of the (unobserved) correlation of the environment of twin pairs is the same for the identical and fraternal twin pairs.

baseline health status were controlled. Controlling health care access, family income, health insurance coverage, smoking, and other health practices or predispositions (one variable at a time) reduced the relative risk by no more than 8 percent (Haan et al., 1987). Living in a poverty tract seems to exert a strong influence on mortality, although the salient characteristics have not been identified.

It is a weakness of existing economic models that environmental variables are typically treated as exogenous. Clearly, residential features of local areas within metropolitan areas are "consumed" in much the same way as houses, automobiles, and other major items of expenditure. Even one's metropolitan area of residence to some extent reflects residential choices, rather than being completely imposed on individuals.

Tastes

Tastes reflect consumer preferences across items of consumption. In a sense, they provide the weights for various consumption items in an individual's utility function. Economists have little to say about how tastes are formed; for an individual, they are usually assumed to be given, although a small literature exists on habit formation and addiction (see Pollak, 1978; Becker et al., 1990).

Are systematic variations in tastes a likely source of socioeconomic differences in mortality? The concept is psychologically so vacuous that it is hard to see how it could prove helpful. Some attribute the high mortality of lower-class groups in Britain primarily to their excessive smoking and drinking (Illsley and Baker, 1991). But it is implausible that manual workers would have a higher taste for such items (in the economists' sense) than others. One could postulate an underlying psychological trait (e.g., ability to defer gratification) that is reflected both in smoking behavior and in failure to finish school. But that moves analysis far afield from economics.

Given values of all of the exogenous variables that we have identified in the economists' models, an individual produces "utility." In more common parlance, he or she achieves some level of satisfaction with life. Furthermore, individuals can project their circumstances into the future and predict their future degree of satisfaction. It is entirely plausible that health behaviors depend on projected levels of satisfaction. That is to say, individuals whose futures appear brighter are more likely to take steps to preserve their health and increase their chances of surviving into the future. If people with lower levels of schooling are more inclined to smoke, it is surely not because they can better afford to do so. Nor, as we indicated, is it sensible to suppose that cigarettes taste better to them. More plausibly, they are more likely to smoke because there is less incentive to preserve their health. Put differently, the daily struggle of poor people to meet their basic needs for food, clothing, and shelter causes them to place lower priority on more distant dangers (Williams, 1990:87).

Social-Psychological Approaches

As we begin to discuss tastes, lifetime satisfactions, and unobserved personality factors that can influence relations between health and class, we have entered the domain of social psychology. The economist's models produce a straightforward prediction about the relation between expected future utility and health behaviors, but testing such predictions benefits from having more direct measures of these variables. In the case of tastes and personality factors, economists have little to offer. Furthermore, they omit altogether what most sociologists consider a key component of utility or satisfaction, the quality of interpersonal relations. Economic man maximizes utility by selecting items of consumption. In other precincts, men and women get married, have babies, develop friendships, and interact with neighbors and relatives.

Psychologists who study health have scales rather than models. Individuals are not seen as pursuing goals but as possessing traits, some of which influence health. Little attention is paid to issues of causation: where the traits came from and whether health events can influence the trait, for example. Trait-bearing individuals are viewed as being subject to stressors that can affect health. These operate principally in the domain of workplace and family. The stressors are typically viewed as exogenous to the individual, although it is clear that avoidance of stress is to some extent subject to personal choice. For example, risk premiums can induce people into hazardous or stressful occupations.

Individuals possess varying amounts of coping skills that allow them to deal with stress. Social relations can facilitate coping and are an important influence on health in their own right. Social relations are also typically treated as exogenous to the individual, although once again it is clear that people are not passive participants in the formation and maintenance of social ties.

There is abundant evidence from hundreds and even thousands of studies that personality traits, exposure to stressors, and social relations are powerful influences on the risk of contracting and dying from chronic diseases, especially heart disease. Useful reviews include House et al. (1988), Marmot and Theorell (1988), and Cohen and Syme (1985). The studies include elaborations of the physiological mechanisms through which psychological variables influence health, sometimes involving other species.

For our purposes, the immediate question is what influence these variables have on socioeconomic differences in mortality and health status. There is much less information about this matter because it has not been an important question in social-psychological studies of health. At times, socioeconomic variables appear in cameo roles as "controls"; at other times they are ignored altogether. For example, a massive volume on *Social Support and Health* contains not a single reference to education, income, social class, or occupation in its 10-page subject index (Cohen and Syme, 1985). Williams (1990) is a notable exception to the bifurcation of literatures (see also House et al., 1990).

The connection between socioeconomic status and stress would appear to be conceptually most straightforward. People with low levels of schooling or low incomes are simply less able to place themselves in low-stress situations. Stressful life events such as unemployment, illness or death of a family member, and divorce are clearly more frequent among people of lower socioeconomic standing (Williams, 1990:89). Such people are also less capable of buying into placid neighborhoods or jobs with high autonomy and low performance pressures. When some indicator of stress is introduced into a multivariate health model that includes a socioeconomic variable, it appears reasonable to treat it as intervening between socioeconomic standing and health.

This conceptual clarity is missing for most personality variables (e.g., sense of self-efficacy). Although such variables may be a product of one's economic circumstances, it is also reasonable to view those circumstances as a function, at least in part, of personality variables. Standard multivariate analysis is not helpful in sorting out such issues of causality. If the introduction of a personality variable into an equation predicting health reduces the coefficient on education, it may mean that education is working "through" the personality variable; that the original coefficient was biased upwards because personality affects education and has its own direct effect on health; or that both are correlated with a third, unmeasured variable that affects each of them as well as health itself.

Similar problems arise for social relations. It is now recognized that personal networks are useful in achieving many goals in addition to better health, including better jobs and neighborhoods. To further complicate interpretation, social networks can be created and activated to perform some of the functions that markets perform by people who cannot afford market solutions (e.g., using a grandparent for babysitting, friends for transportation, a spouse for entertainment). On the other hand, people with higher incomes can afford to pursue social relations in more pleasant venues, perhaps increasing their durability and strength (probably a very salient factor in spousal relations). Finally, one suspects that good social relations are a function of some of the same traits that are related to job success, such as sociability and self-control. Sorting out causal pathways in the connections among social relations, socioeconomic status, and health is clearly difficult. Using longitudinal data, Johnson (1991) finds that poor mental health in creased the risk of breaking primary relationships, whereas weak primary relationships increased the subsequent risk of mental distress.

Empirical Studies

People with lower levels of education, income, and occupational status have an adverse distribution on most of the biomedical and behavioral variables related to health. The behavior to which the largest number of excess deaths are attributable in the United States is cigarette smoking. Table 8-7 shows recent differences in smoking patterns by education and family income in the United States. By 1987, there was a huge negative educational gradient in smoking for males and a somewhat milder one for females. These sex differences are likely to be related to the milder mortality gradient for women than men, demonstrated earlier. If we adopt the estimate of relative risk from smoking of approximately 1.7 that has emerged from many epidemiologic studies (see Rogers and Powell-Griner, 1991, for recent figures), then smoking differences alone could account for a male mortality differential of 15 percent between those who did not complete high school and those who completed college. Income differences in smoking are substantially smaller than educational differences, consistent with the conclusion of Winkleby et al. (1992) about the dominant impact of

TABLE 8-7 Socioeconomic Differences in the Prevalence of Cigarette Smoking: United States, 1987

	Males (%)			Females (%)		
Indicator	Current Smoker	Former Smoker	Never Smoker	Current Smoker	Former Smoker	Never Smoker
Years of schooling						
<12	40.5	32.3	27.1	30.7	13.9	55.5
12	35.9	27.6	36.6	29.6	17.4	53.0
13-15	26.8	26.5	46.7	24.4	18.4	57.2
16+	17.4	29.7	52.9	15.1	21.5	63.5
Family income (dollars)						
<10,000	35.9	23.2	40.9	29.0	12.9	58.2
10,000-19,999	36.3	30.1	33.6	29.8	16.3	53.8
20,000-34,999	33.7	27.1	39.3	27.9	17.5	54.6
35,000-49,999	26.5	31.0	42.5	25.3	19.4	55.2
50,000+	23.2	31.4	45.4	19.5	24.3	56.2
All	31.2	28.9	39.9	26.5	17.4	56.0

SOURCE: National Center for Health Statistics (1989).

education on smoking in a multivariate analysis of data from a nonnational sample.

Shea et al. (1991) examine educational differentials for a variety of risk factors in a 1989 New York State sample. They find that better-educated people are significantly more likely to engage in aerobic exercise and to know their blood pressures, and less likely to smoke or be overweight. Using 1979-1986 data from the Stanford Five City Project, Winkleby et al. (1990) find that schooling is significantly associated with cigarette smoking, hypertension, serum cholesterol, body mass index, height, and health knowledge (a 17-item scale of knowledge about cardiovascular risk factors). In all cases, the risk factor distribution of poorly educated persons is more adverse. In the Alameda County Study, persons of lower socioeconomic standing were three to four times more likely to report bad health habits (Berkman and Breslow, 1983). Scherwitz et al. (1991) show that scores on a hostility scale, sometimes found to be related to the incidence of coronary heart disease, were higher for people with less schooling and suggest that the distribution of hostility scores reflects the incidence of negative life events and the availability of social support.

The larger, nationally representative NHEFS data set also demonstrates that more poorly educated persons are more likely to smoke, to have high blood pressure, and to be overweight (among females). However, differences in mean serum cholesterol levels are small and irregular (Feldman et al., 1989:Table 5). Sorel et al. (1992) find that the inverse univariate correlation between blood pressure and education reported in the Second National Health and Nutrition Examination Survey and its Hispanic counterpart is substantially attenuated or becomes statistically insignificant once age and a body mass index are controlled. With these controls, the only significant negative relationship between education and blood pressure occurs for white male's systolic pressure. A new biomedical factor that has begun to receive attention as a potentially important mediating variable in the relation between class and coronary heart disease is plasma fibrinogen, a blood protein related to clotting. Evidence suggests that it is an important independent risk factor for cardiovascular disease; in Finland, levels are significantly associated with both childhood and adult socioeconomic status (Wilson et al., 1992).

British studies also demonstrate that people in higher occupational classes are more likely to be tall, to be physically active, and to have good respiratory function, and less likely to smoke or be overweight (MacIntyre, 1988; Marmot et al., 1984). Once again, serum cholesterol differentials are negligible. Oakley and Rajan (1991) also show that working-class women in England have fewer close friends and receive less support from their husbands than middle-class women and are no more closely involved with relatives.

In order to determine the impact of these and other "proximate determinants" of health on class gradients in mortality and health status, we examine four studies that are unusually rich in the array of variables considered. Problems of identifying causal relations are not fully resolved in these studies, but they suggest which mechanisms may be most important to clarify. The first is the well-designed NHEFS study reported by Feldman et al. (1989). The authors note that educational differentials in mortality are much greater for heart disease than for other causes of death. They proceed to introduce information on current smoking status, body mass index, systolic blood pressure, and serum cholesterol into a hazard model predicting the risk of death from heart disease. Each of these variables is a simple dichotomy. Although some reduction in relative risk for the poorly educated is observed for most age-sex-education groups, the reductions are small. For males ages 65-74, for example, the relative risk associated with the most poorly educated group (0-7 versus 12+ years) declines from 1.49 before the introduction of controls to 1.38 after their introduction. For females, the comparable change is from 1.53 to 1.48 (Feldman et al., 1989:926, 928).

The second study examines the mortality of 17,530 London civil servants over a 10-year period (Marmot et al., 1984). The principal socioeconomic dimension in the study was occupational grade: administrative, professional/ executive, clerical, and other (the lowest grades). Very large differences in mortality were observed among these occupational classes, with the lowest class having an age-adjusted mortality probability of 15.6 percent, compared to 4.7 percent among the highest grade. The most important cause of death in producing the differential was coronary heart disease. Measures of important proximate determinants of mortality were available in this study. In a logistic regression predicting the risk of death from coronary heart disease, introducing information on smoking status, systolic blood pressure, serum cholesterol levels, blood glucose, and height reduced the risk associated with grade by less than 25 percent. Introducing physical activity levels and disability at baseline also had little effect on occupational coefficients.

The third and fourth studies have richer detail on social-psychological variables. In an exceptionally well-crafted study, Lundberg (1991) examines an index of physical health among 5,613 Swedes aged 15-75. A dichotomous health index was constructed from a 47-item list of symptoms and ailments; 41 percent were classified as ill. The prevalence of illness was sharply differentiated among eight occupational groups, which formed the principal socioeconomic variable studied. A wide array of additional variables were available, including "economically harsh" conditions in childhood, economic deprivation in adulthood, heavy labor on the job, dangerous work conditions, psychologically stressful job, high decision latitude on the job, weak social network, poor diet, heavy smoking, and heavy alcohol con sumption. Except for psychologically stressful work, each of these variables shows a distribution that is adverse to lower occupational grades.

The study uses dummy variables to indicate membership in a particular occupational group. The standard deviation of occupational coefficients is used as the basic measure of class inequality in health status. With controls only for age and sex, the standard deviation is 0.231. Introducing all of the above variables, including an interaction between stressful job and decision latitude suggested by Karasek et al. (1981), reduces the standard deviation to 0.147, or by 36 percent. Introducing variables one group at a time shows that the combination of heavy work and dangerous work conditions produced the largest reduction, 15 percent. The two psychological features of one's job, and their interaction, reduced class inequality by only 3 percent. Among these added variables, the highest relative risk was associated with having economic difficulties in one's family during childhood.

The fourth study is not explicitly addressed to socioeconomic status, which is treated as a control variable. However, a rich array of other variables is included, and the presentation allows an inference about the impact of these variables on socioeconomic differences. Kaplan (1985) reports on ischemic heart disease (IHD) mortality in an 18-year follow-up study of 6,928 adults in Alameda County, California. Adjusting for age, sex, and physical health status at baseline (1965), the study finds a relative risk of 1.40 for persons of low socioeconomic status, defined as having less than 8 years of schooling and low income. Adjustment for poor health practices (constructed from a scale including smoking, drinking, weight for height, physical activity, and hours of sleep) reduces the relative risk by 9 percent. Adjusting for social network (isolated versus connected) reduces the relative risk by 11 percent. Adjusting for "life satisfaction" reduces the relative risk by 3 percent, for "depression" by 5 percent, and for "helplessness" by 7 percent. Introducing all of these variables simultaneously, as well as "perceived health," reduces the relative risk to 1.03, which is insignificantly different from unity. The introduction of "perceived health" as an independent variable in the regression format is unfortunate because it seems more appropriately treated as an outcome variable than a predictor and may bias coefficients toward 1.00. Among the psychosocial variables introduced in this study, dichotomized life satisfaction and depression indices produce relative risks of IHD death of 1.49, and helplessness a relative risk of 1.77. Only the latter remains significant in multivariate analysis.

Thus, in three of these four studies the introduction of what might be considered intervening variables between class and health fails to reduce socioeconomic differentials by as much as 40 percent. The other study, which is rich in psychosocial variables, essentially "explains" all of the differential, although issues of causality (e.g., what causes helplessness) are not resolved in this study. In addition, it appears that socioeconomic differ ences are unusually narrow in the Alameda County population. In fact, at ages 60+, 17-year survival is not significantly associated with family income (adjusted for family size; Kaplan et al., 1987).

The persistent failure of intervening or proximate variables in existing studies to "account for" relations between class and health has led some analysts to postulate that there is some generalized factor that is primarily responsible for the observed differences (Cassel, 1976; Marmot et al., 1984). Marmot et al. suggest that dietary differences may be one such generalized factor. But factors related to diet such as serum cholesterol, blood pressure, and body mass index are clearly not principal channels connecting class and health. Access to, and quality of, medical care may be another such factor; surprisingly little research attempts to understand the contribution to class differences of variation in medical care. But the experimental studies described above, the widening of class differences in Britain after the National Health Service was introduced, and the widening of education differences above age 65 in the United States after Medicare was introduced all suggest that medical care does not hold the key to socioeconomic differences. So does the simple tabulation of the many chronic conditions that are more prevalent among lower-status groups (shown, for example, in Table 8-5). Clearly, the incidence of many diseases varies among groups, and by its nature, medical care has much less to offer in the way of prevention than of treatment.

The search for one generalized factor to explain the bulk of class differences is likely to prove fruitless. More and better studies of specific factors would seem a more promising path, within a causal framework that recognizes that individuals are not mere slices of cross-sectional characteristics but have histories and motivations.

SOURCES OF CHANGE IN SOCIOECONOMIC DIFFERENCES

In most Western countries, differentials have widened in the past several decades, and some attention has been paid to the factors involved. The widening of class differentials in the United States and Britain during this period coincides with a widening of class differentials in cigarette smoking. Between 1974 and 1985, the prevalence of smoking in the United States declined five times faster among college graduates than among people with less than a high school education (Pierce et al., 1989). To our knowledge, no one has attempted an explicit quantitative assessment of the linkage between these trends. However, Marmot and McDowell (1986) demonstrate for Britain that between 1970-1972 and 1979-1983, mortality from smoking-related causes lung cancer and coronary heart disease rose among manual workers and fell among nonmanual workers. For all other causes, mortality rates fell by equal percentages in the two groups.

Winkleby et al. (1992) demonstrate that in the Stanford Five-City Project, improvements in levels of smoking, blood pressure, and serum cholesterol (men only) were actually greater among poorly educated people (less than high school) than among college graduates. This unusual pattern of change was thought to be partly a product of a comprehensive program of community organization and health education. However, similar changes were also observed among control cities. The interaction between time trends and education was not statistically significant.

To investigate the role of health services in the widening class gap in England and Wales, Mackenbach et al. (1989) divide detailed causes of death into those that are amenable to medical intervention and those that are not. Although larger percentage declines for the amenable causes were observed for higher classes between 1931 and 1961, no such trend was evident between 1961 and 1981. Thus, it does not appear that differential access to medical care was a significant factor in widening class differentials during the later period.

Income distributions have become more unequal both in the United States and in England and Wales during the past 15 years. In the United States, these disparities have resulted in higher "returns to education" (i.e., greater disparities in income between educational groups). Obviously, these changes could also be related to changes in educational differentials in health. No one has examined this issue in the United States, to our knowledge. In Britain, Wilkinson (1989) argues that, although trends in mean earnings by class cannot account for widening mortality differentials by occupational group, trends in class differences in poverty are plausibly implicated.

RACE, CLASS, AND HEALTH

Race is a dimension of social stratification in the United States that interacts with, but is separable from, education, income, and occupational class. For example, residential segregation between the races is markedly greater than segregation between even the most extreme income or occupational groups (White, 1987). Preston and Haines (1991) note that at the turn of the century, social class differences in American child mortality were very small, especially in comparison to England and Wales, but racial differentials were enormous.

Black life expectancy has trailed white life expectancy throughout the twentieth century. Racial differences have narrowed since 1970 (Manton et al., 1987); they were 7.4 years in 1960 and 5.8 years in 1985. If white age and cause-specific death rates were substituted for the equivalent black rates, the largest reduction in black mortality would be produced by changes in heart disease for females and homicide for males (Manton et al., 1987).

Blacks have a higher prevalence of most chronic conditions and of disability in all age groups (Manton et al., 1987). Recorded black-white mortality differences contract sharply above age 65 and are eliminated or reversed above age 80.

More studies have aimed at "explaining" black-white differences than at explaining other socioeconomic differences, and they have been far more successful. The principal reason is that the factors admitted into the explanation have included the other socioeconomic variables. In short, black-white differences in mortality and health status appear to be primarily a manifestation of racial inequality in education and income.

Otten et al. (1990) use NHANES follow-up data on persons aged 35-54 at baseline. An initial black-white mortality ratio of 2.3 with no controls is reduced to 1.4 after controls are instituted for six risk factors (e.g., blood pressure, smoking) and family income. By far the largest reduction in relative risk occurs when family income is introduced into the hazard model. At ages 55-77, a slight black mortality disadvantage is converted into a slight black advantage when these same factors are controlled.

Behrman et al. (1991) use longitudinal data from the Retirement History Survey to examine the degree to which black-white differences in male mortality are attributable to differences in income. This data source is especially useful in having measures of lifetime earnings, but is limited to persons who were heads of households at survey in 1969, when they were aged 58-63. In a later version of this analysis, Behrman et al. (1993) find that both Social Security and pension benefits have a highly significant effect on the mortality hazard rate. Using a regression-decomposition procedure, they find that differences in characteristics between blacks and whites account for 60-80 percent of the racial difference in hazard rates. Most of the contraction is attributable to differences in pension income, education, and marital status (Behrman et al., 1993:174)

In a study that draws on the 1986 National Mortality Followback Survey for numerators and the 1986 National Health Interview Survey for denominators of adult death rates, Rogers (1992) finds an odds ratio of 1.48 between black and white mortality when only age and sex are controlled. Controlling marital status and family size alone reduces the odds ratio to 1.29. Controlling family income class alone reduces it to 1.17. Controlling both variables together reduces the odds ratio to 1.01.

In a study using NLMS and confined to comparisons of age-adjusted death rates, Sorlie et al. (1992) show that controlling family income levels reduces the relative risk of death for black males aged 45-64 from 1.67 to 1.30 and for black females from 1.82 to 1.48. Racial differences were smaller above age 65 and not substantially modified by income controls.

Keil et al. (1992a) examine black-white differences in mortality from all causes and from coronary heart disease among men recruited into the

Charleston Heart Survey in 1960. Educational level and occupational status at baseline served as socioeconomic control variables in a 28-year follow-up. Initially large black-white differences in all-cause and coronary heart disease mortality were reduced to insignificance when socioeconomic status was controlled. In a subsequent analysis of these data, Keil et al. (1992b) find that skin color within the black population is insignificantly related to mortality, although there is some tendency for lighter-skinned blacks to have lower survivorship.

Mutchler and Burr (1991) examine racial differences in disability and other indices of health status using the 1984 Survey of Income and Program Participation. They find no significant racial differences once social and economic variables are controlled. The most influential of these variables are education and net worth. However, racial differences in self-assessed health status (proportion rating their own health as fair or poor) remained significant.

Other studies have examined cancer incidence and survival differences between blacks and whites. Devesa and Diamond (1983) find lung cancer incidence rates to be higher for black men than for white men in the Third National Cancer Survey. However, when the median income and median educational level of one's census tract are introduced into a regression equation, racial differences become insignificant. Bassett and Krieger (1986) note that blacks have poorer survival rates from breast cancer than whites, controlling stage and histology. Racial differences in survival are also common at other sites. Using data from the Western Washington Cancer Surveillance System, the authors find that an initial racial difference of 35 percent is reduced to 10 percent when socioeconomic characteristics of one's census tract are controlled.

Economic characteristics may affect cancer survival largely through the quality of care received; Page and Kuntz (1980) show that racial differences in survival are insignificant among patients treated in Veterans Administration hospitals for seven of the eight cancer sites investigated. Blendon et al. (1989) show that blacks are less likely to use physician services at a particular level of self-assessed morbidity as reported in a national telephone survey in 1986. They are also less likely to express satisfaction with the quality of care received. Use of a single dichotomous income variable, plus health insurance availability and demographic controls, reduces an initial difference of 26 percent in the mean number of annual ambulatory visits to physicians to a difference of 10 percent, which remains significant.

Four factors are likely to be significant in the narrowing of adult racial differences in mortality during the past two decades, although there has been no explicit examination of this phenomenon. First, racial differences in cigarette smoking have contracted (Manton et al., 1987). Second, there has been a huge reduction in the prevalence of hypertension among blacks, especially black males. Nevertheless, blacks have an approximately 30 percent higher incidence of hypertension even when obesity and diabetes are controlled statistically (Svetkey et al., 1993). Third, the introduction of Medicare and Medicaid has been associated with a change in patterns of physician visitation and hospitalization, with black increases exceeding white (Manton et al., 1987). Finally, racial differences in income and poverty rates have narrowed, although there is some ambiguity about trends in racial income disparities (National Research Council, 1990). These four sets of changes are clearly interrelated rather than independent.

Navarro (1990) notes that the United States has an explicit policy goal of narrowing racial differences in mortality and health status, but, unlike most other industrialized countries, has no explicit goals regarding socioeconomic differences. In light of careful research that demonstrates income, education, and occupational disparities to be the principal source of racial differences in mortality and health status, the policy emphasis would appear to be misplaced. Now that reliable national data on socioeconomic differences have become available, there is less reason to continue using race as a proxy for class.

SUMMARY

Mortality rates and the prevalence of ill health are higher among groups of lower social standing in all contemporary Western countries, including the United States. In most countries where evidence is available, social disparities in mortality have widened during the past two decades, although inconsistencies among data sources in the United States make this conclusion uncertain. Heart disease is the principal cause of death responsible for social class differences in mortality from all causes combined.

The principal approaches used to identify the sources of these differences are economic and social-psychological. Economic approaches have the virtue of conceptual clarity; social-psychological approaches have the advantage of focusing on variables that have substantial predictive ability. The former focuses on choice under constraints; the latter, on predispositions of unknown origin, stressors, and coping mechanisms. In neither case are individuals' personal histories well integrated into the analytic apparatus, which seems essential for a full appreciation of the sources of health differentials at any moment in time. A fruitful blending of the approaches seems possible in which the economist's focus on goods and services as the principal source of satisfaction is supplemented by attention to personal relationships as additional desiderata. Poverty and low status exact a health toll not only through absolute deprivation of material resources but also through interpersonal stresses and impaired relationships, some of which may reflect relative deprivation as much as absolute deprivation. These influences cumulate over a lifetime. Research designs need to be expanded to capture the broad array of class-related phenomena affecting the health of older persons.

Efforts to ascribe class differences in mortality or health status to various intervening biomedical variables such as smoking or elevated blood pressure have not been entirely successful. Although some reduction in class differences typically results from controlling these variables, the bulk of the differences remains. Whether this result reflects a deficiency in the array of variables considered, the activity of hitherto unidentified factors, or the futility of a strictly biomedical approach to studying a process with important cognitive, affective, and motivational elements, is not clear. In contrast, the bulk of black-white differences in mortality and health status are explicable in terms of the unequal distribution of the groups on variables such as education and income.

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9

Geographic Concentration, Migration, and Population Redistribution Among the Elderly

Frank D. Bean, George C. Myers, Jacqueline L. Angel, and Omer R. Galle

This chapter examines what is known about patterns of geographic distribution (and redistribution) of the elderly population, focusing mainly on the United States. At a national level, the general pattern of population aging around which spatial variations occur is relatively well known. From 1980 to 1990 the population of the United States increased by 9.8 percent, while among those aged 65 years or older, the increase was substantially greater (22.3 percent). Hence, as a result of its more rapid growth, the population aged 65 and over increased from 11.3 percent of the total U.S. population in 1980 to 12.6 percent in 1990 (Taeuber, 1992). In the future, the U.S. population is expected to continue to age slowly for the next several years and then to age more rapidly as the large birth cohorts of the "baby-boom" years begin to reach retirement (Soldo and Agree, 1988; Uhlenberg, 1992). Bureau of the Census population projections forecast that the proportion of the population aged 65 and over will grow to 13.2 percent by 2010 and then jump to 20.2 percent in 2030 (Day, 1992: Medium variant).

The occurrence and effects of aging are not evenly experienced throughout the country. The public policy implications of population aging are felt not

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only at the national level, but are also important at the state and local levels (Zedlewski et al., 1990; Crown, 1988; Longino, 1990), where the provision and funding of many health and social service programs occur (Sternlieb, 1991; Mayer, 1991). A noteworthy example is Medicaid, the major federal and state program for providing medical care to the poor. Even though the elderly comprised only about one-seventh of Medicaid beneficiaries in fiscal year 1987, they accounted for one-third of Medicaid payments to health care providers (Kane and Kane, 1990; Ward-Simon and Glass, 1988). States whose populations are disproportionately made up of the aged will accordingly shoulder larger relative financial responsibilities for Medicaid (and other state and locally funded programs) because of their age structure.

The relative contributions of fertility, mortality, and migration to population aging differ at the subnational compared to the national levels. Although geographic variations in fertility and mortality patterns make small contributions to differential rates of aging among states and regions, patterns of internal migration seemingly account for most of the variation (Rogers, 1992a; Serow et al., 1990; Frey and Speare, 1988). And given the rising levels of immigration experienced by the United States since World War II, the age pattern of net international migration is likely to exert an increasing effect on population age composition. This factor is undoubtedly more important for explaining subnational temporal and geographic variations in population aging than it is for explaining population aging at the level of the nation as a whole. The reasons are that the postwar growth in net international migration is relatively recent (occurring mostly over the past 20 years) and that immigrants tend to concentrate in only a few states (Bean et al., 1989; Bean and Tienda, 1987).

The purpose of this review is to examine the geographic distribution of the elderly population in the United States and the factors that contribute to its change over time (especially migration). The first section of the chapter summarizes patterns of elderly geographic concentration in the country, including regional and urban/metropolitan patterns. The second section focuses on patterns of elderly and nonelderly population redistribution and on patterns of migration that contribute to redistribution at various spatial levels of analysis. The third section examines the results of research about migration, focusing on both elderly and nonelderly migration behavior, each of which holds implications for patterns of population redistribution by age. A fourth section introduces international comparisons, not only for what they reveal about migration and redistribution in other countries, but also for what they imply about U.S. patterns and their explanation. The fifth section specifies some of the major remaining gaps in knowledge about elderly migration and redistribution, and assesses the extent to which newly developed and recently available data sets might contribute to their resolution.

PATTERNS OF GEOGRAPHIC DISTRIBUTION

Examining the geographic distribution of the older U.S. population requires establishing a meaningful and useful operational definition of the elderly. Demographers typically define the elderly population as those individuals aged 65 years or older, whereas gerontologists sometimes use age 60 as the cutoff. Some agencies within the U.S. government (e.g., the Administration on Aging) and within the United Nations (e.g., the Population Division) use age 60 as a cutoff point, whereas others (e.g., the National Institute on Aging) use age 65 (Myers, 1990). Some migration researchers advocate 60 years as a boundary (Longino et al., 1984), and others argue that 65 is preferable for measuring elderly population stocks, even though acknowledging that for some purposes 60 may constitute a preferred delineation for assessing elderly migration flows (Rogers, 1992b). In this chapter we use 65 years or over, in part because it is consistent with the usage of the Bureau of the Census in recent reports on the aged population (Taeuber, 1992). In the final analysis, however, the multiple definitions used by different researchers and agencies serve as a reminder (1) that any definition of the elderly population is somewhat arbitrary and (2) that the elderly population has diverse characteristics. For example, researchers and policy makers are paying increasing attention to the so-called oldest-old, a group usually (but not always) defined as those aged 85 years or over. The importance of this group derives not only from its rapidly growing size but also from the fact that it differs substantially in a number of ways from the younger-old (65-74 years) and the middle-old (75-84) (Suzman et al., 1992; Taeuber and Rosenwaike, 1992; Binstock, 1992). In recognition of the increasing significance of the oldest-old, we also introduce data pertaining to the geographic distribution of the population aged 85 and over.

The extent of aging in different populations can be compared by calculating the proportions of individuals in those populations who have reached age 65. Calculating a mean or a median age provides an alternative method for assessing population aging (e.g., Preston et al., 1989). It is important to remember that these measures—the proportion 65 years and over and mean age—provide information about different aspects of population aging (Liao, 1993). The former provides a better measure of old-age concentration than the latter to the extent that the age distributions under comparison are differentially affected by changing age patterns of migration, which might occur as a result of substantial net international immigration to some states but not others. In general, it is increasingly important to consider both measures as the volumes of net migration and net international migration increase and as the age structures of in-migrants and out-migrants, and of immigrants and emigrants, change in relation to that of the host population. And at another level, neither the proportion of elderly nor the mean age may suffice for some purposes. Organizations interested in social service planning or in targeting certain marketing strategies may need information about the absolute size of the elderly population living in a given geographic area (Myers, 1990). In what follows, we at times make use of each of these alternative measures.

Patterns of Regional Concentration

The geographic distribution of the elderly may be approached in either of two ways. The first, called geographic concentration (Rogers, 1992b), focuses on the *share* of a nation's total elderly population residing within given geographic boundaries. Viewed in this way, more than half (52.2 percent) of the elderly population of the United States in 1990 resided in just nine states (California, Florida, Illinois, Michigan, New Jersey, New York, Ohio, Pennsylvania, and Texas; see appendix to this chapter). In some respects, however, this pattern is less interesting than it might at first seem because these same states in 1990 contained 51.8 percent of the country's total population, a share nearly identical to their percentage of the elderly. For our purposes, a second approach for examining geographic distribution, termed age concentration (Rogers, 1992b), is preferable because it provides an indication of the extent of aging within an area. This approach calculates the proportion of elderly within given geographic boundaries. Thus, for example, in 1990 the elderly constituted 18.3 percent of the total population of Florida, whereas this age group made up only 4.1 percent of the population of Alaska (see appendix).

Generally speaking, in moving from smaller to larger geographic units (from counties to states to regions, for example), differences in the proportion of the elderly among areas become less pronounced (United Nations, 1992). Examining the proportion of elderly in 1990 in aggregations as large as Census Bureau regions, however, reveals several interesting patterns (Table 9-1). First, all regions of the country experienced growth rates among their elderly populations between 1980 and 1990 that exceeded their rates of population growth (see also Siegel, 1993). Thus, in all parts of the country, the number of elderly grew faster than the rest of the population. Second, although in 1980 the elderly were appreciably overrepresented only in the Northeast, in 1990 they were overrepresented in both the Northeast and the Midwest. Third, on a regional basis in 1980, the oldest-old were distributed more or less in proportion to population, whereas by 1990 the Northeast and Midwest showed disproportionately high numbers of persons in this age group. Fourth, between 1980 and 1990, the oldest-old population grew substantially and increasingly became overrepresented in the Northeast (especially in the New England states) and in the Midwest (especially in the Great Plains states). Although the rate of growth in the oldest-old popula tion was sizable, the relative and absolute size of this group is not very large in relation to the younger- and middle-old groups. But the oldest-old use a substantially disproportionate share of health and social services (Binstock, 1992). For example, those aged 85 and older are more than 20 times as likely to reside in nursing homes as persons aged 65-74 (Hing, 1987).

TABLE 9-1 Measures of Population Aging for Regions, 1980-1990

	Number of Persons 65 and Over		Number of Persons 85 and Over		Median Age (years)
Region	1980	1990	1980	1990	1990
U.S. total	25,549	31,242	2,240	3,080	32.9
Northeast	6,071	6,995	547	710	34.2
Midwest	6,692	7,749	649	840	33.0
South	8,488	10,724	664	992	32.8
West	4,298	5,774	380	539	31.8
	Percentage 65 and Over		Percentage 85 and Over		
	1980	1990	1980	1990	
U.S. Total	11.3	12.6	1.0	1.2	
Northeast	12.4	13.8	1.1	1.4	
Midwest	11.4	13.0	1.1	1.4	
South	11.3	12.6	0.9	1.2	
West	10.0	10.9	0.9	1.0	
	65 and Over Relative Change	Absolute Change	85 and Over Relative Change	Absolute Change	
U.S. total	11.5	22.3	20.0	37.5	
Northeast	11.3	15.2	27.3	29.9	
Midwest	14.0	15.8	27.3	29.3	
South	11.5	26.3	33.3	49.5	
West	9.0	34.3	11.1	41.6	

SOURCES: 1980 and 1990: Bureau of the Census (1992b); median age, 1990: Bureau of the Census (1992a).

It is also interesting that at the level of aggregation of states the data reveal the complex nature of the processes generating patterns of elderly population distribution. For example, several of the states of the industrial midwest (e.g., Indiana, Illinois, and Michigan) show above-average *rates of growth* in their proportion of elderly, even though their proportions of eld erly and median ages are about the same as the country as a whole. The midwestern farm states, however, show high proportions of elderly but not unusually high rates of growth (see appendix). California shows a below-average rate of increase in its proportion of elderly, at the same time that its growth in the absolute number of elderly is far above average and its median age is below average. And New York reveals a quite high median age, but a proportion of elderly not much above average.

A number of different processes generate these patterns. In the case of the midwestern farm states, it is likely that outmigration of nonelderly during the 1980s contributed to population aging (Frey, 1993). In California's case, the large (in absolute numbers) aged population that grew during the 1970s in part as a result of high inmigration of the elderly is not readily discernible in either 1980 or 1990 census data in the proportion aged 65 and over. Part of the reason is that California experienced outmigration of the elderly during the 1980s that was nearly as great as inmigration (DeAre, 1992). Also, in both 1980 and 1990, substantial immigration—the age distribution for which is somewhat younger than that of the general population (Arthur and Espenshade, 1988)—masked the increase in California's large aged population, as did the high fertility of the state's large Hispanic population (Bean and Tienda, 1987). Similarly, New York's figures are also influenced by immigration, with a substantial negative net internal migration balanced by positive net international migration.

Patterns by Size and Type of Place

The elderly population is also variously distributed according to size and type of place. Since 1950, the United States population has increasingly resided in cities. In broad outline, this is true of the elderly population as well, although in part it depends on what is meant by the term "city." If the focus is only on urban versus rural residence (on whether people live in incorporated places of more than 2,500 inhabitants versus living in smaller places), then in 1990 the percentage of the elderly living in urban places is almost exactly the same (75.8 percent) as the percentage of the total population living in urban places (75.2 percent). Furthermore, both of these figures have changed by almost the same amount over the past 40 years, moving from about 64 percent urban in 1950 to about 75 percent urban in 1990 (Serow et al., 1990; Bureau of the Census, unpublished tabulations). By contrast, if the focus is on residence in metropolitan versus nonmetropolitan areas (roughly on living in localities with more than 100,000 inhabitants), the elderly are somewhat less likely to live in metropolitan areas than the total population (74.0 percent for the elderly versus 77.5 percent for the total), although both groups have become increasingly metropolitan since 1950 (Golant, 1992; Bureau of the Census, unpublished tabulations). Thus, the elderly are somewhat more likely than the general population to live in nonmetropolitan urban places (i.e., in smaller towns and cities), a tendency that is also reflected in their migration behavior, as we note below. Within metropolitan areas, however, the elderly are about as likely as the general population to live in central cities (31.0 versus 31.3 percent, respectively, in 1990; Bureau of the Census, unpublished tabulations). However, 40 years ago the elderly were much more likely to reside in central cities, a difference that has diminished as larger proportions of the elderly have come to reside in suburbs. By 1990, for example, 43.0 percent of the elderly, as compared to 46.2 percent for the total population, were living in suburbs (Bureau of the Census, unpublished tabulations; Golant, 1992).

Broadly speaking, these patterns reflect the general urbanization and suburbanization tendencies characteristic of postindustrial societies in the post-World War II period (Champion, 1989; Frey, 1988; Hall and Hay, 1980). One of these has consisted of increasing urbanization and metropolitanization, although the latter process slowed down and in some cases slightly reversed itself during the 1970s, before reemerging in the 1980s (Frey, 1992b). The other has consisted of increasing suburbanization within metropolitan areas, as movement has occurred away from central cities outward to suburban areas (Frey, 1992a). These trends, however, are less characteristic of the elderly than of the nonelderly, thus reinforcing the point that the redistribution patterns of these groups require separate study.

POPULATION REDISTRIBUTION AND MIGRATION

Populations defined on the basis of geographic boundaries are constantly involved in the process of redistributing their members from one geographic subarea to another. When the concern is with the distribution of population characteristics and their change over time (as is the case here, given the interest in age structure), it can be somewhat misleading to speak in terms of "redistribution" because the term implies the geographic mobility of persons defined as making up the population. However, geographic mobility is only one of several mechanisms that can affect the distribution of population characteristics such as age. As noted above, the age structures of states and regions are affected by fertility, the age pattern of mortality, the age pattern of net internal migration, and the age pattern of net international migration. As a result of the former two processes acting alone, the proportion of elderly within an area can change over time without any geographic mobility occurring.

Little research on the magnitude of the contribution of each of these components to population aging at the region or state level has been carried out. Studies have been conducted that distinguish the contributions to aging of (1) net migration and (2) natural increase (often called aging-in-place; Rogers and Woodward, 1988; Clifford et al., 1983; Lichter et al., 1981; Fuguitt and Beale, 1993; Siegel, 1993). The contribution of net migration reflects the extent to which the proportion of elderly in a given area is affected by the net geographic movement of older persons to that area, whereas that of aging-in-place reflects the extent to which the proportion of elderly in a given area is affected by persons already living in the area reaching age 65. It is important to note that this latter component, the aging-in-place component, will itself consist of fertility, mortality, internal migration, and international migration subcomponents. The latter two factors influence the size of the nonelderly population "at risk" of reaching age 65. To our knowledge, no research has sought to estimate the magnitude of each of these separate subcomponents of aging-in-place.

Despite the relative lack of research on the magnitude of these components, it seems likely that fertility and mortality differences will not account for a great deal of the contemporary variation in age structure among U.S. subnational geographic units because of recent geographic convergence over time in fertility and mortality patterns (Serow et al., 1990; Frey and Speare, 1988; Goldstein, 1976). The major determinant of both cross-sectional and dynamic geographic variations in population aging thus is probably the age pattern of net internal migration, which affects the proportion of elderly within a geographic area in two ways. As noted above, one is by virtue of the elderly themselves moving into or out of an area in sufficient numbers to change the age structure appreciably. Given that outmigration among the elderly is not nearly as location-specific as inmigration (Rogers, 1992a), the latter makes by far the greater difference. States and areas that have attracted large numbers of elderly in-migrants are Florida, Arizona, California, the lake regions of Michigan and Minnesota, the Ozarks region of Arkansas and Missouri, Oregon, and Washington (Rogers and Watkins, 1987; Rowles, 1986). By far the most significant of these in terms of the numbers involved is Florida, which has been a destination for elderly migrants for at least three decades (Rogers and Woodward, 1988).

A second way aging can occur through internal migration is as a consequence of migration of the nonelderly (Frey, 1986; Graf and Wiseman, 1978; Fuguitt and Beale, 1993). For example, states and regions that have experienced substantial outmigration of the nonelderly, often apparently seeking better employment opportunities as a result of industrial restructuring, have experienced aging as a result of this process. These include the farm states of the Midwest and the New England states of the Northeast, all of which experienced outmigration of nonelderly during the 1970s and early 1980s, as well as the industrial midwestern states which experienced increases in outmigration during the 1980s (Long, 1988). Moreover, the influence of this type of migration on U.S. population aging over the past

10 years has been much more significant than outmigration of the elderly. It has involved many more movers than is the case among the elderly, both because the numbers of nonelderly are larger and because younger persons are much more likely to move (Long, 1988; Frey, 1986). This difference in behavior by age emphasizes the need to adopt a life-course migration perspective in the assessment of the influence of migration on the aging patterns of states and regions, especially to the extent that nonelderly groups display different life-course migration patterns than the elderly (Frey, 1986).

In addition to differing in number and in the propensity to migrate, the elderly are more focused than the nonelderly on their preferred migration destinations, which has implications for population redistribution (Rogers, 1992b). In broad outline, the two major patterns of post-World War II migration consist of (1) movements away from the Northeast and Midwest toward the West and South, and (2) a tendency toward increasing metropolitanization (a pattern as we note below that was reversed for some segments of the population during the 1970s). In the case of movement to the West and South, the elderly and the nonelderly have shown similar tendencies to move to these destinations, although the elderly have been more likely to migrate to areas attractive to retirees. As the most recently available census data in Table 9-2 show, these include the states of the South Atlantic division (especially Florida) in the South and the states of the Mountain division (especially Arizona) in the West (Rogers, 1992a). Within the general postwar pattern of westward and southward movement, Longino (1985) notes a "Continental Divide" pattern involving movement south of persons originating east of the Mississippi River and movement west of persons originating west of the Mississippi River (see also Friedsam, 1951). This tendency characterizes both the elderly and the nonelderly, although it emerges in somewhat more exaggerated form among the elderly.

The greater tendency of the elderly than of the nonelderly to move to the South and the West in recent decades implies a migration on their part that is motivated more by nonlabor market factors than is the case among the working-age nonelderly. This inference is also supported when we turn to an examination of data relevant to the second major postwar pattern—increasing metropolitanization. Compiled by Frey (1992b), these data are displayed in Table 9-3, and show the percentage distribution of the elderly and nonelderly across regional and metropolitan categories from 1960-1990, as well as the percentage change in the distribution by decade. Because they show similar patterns, the Northeast and Midwest regions are combined into one (labeled North), and within regions, metropolitan residence is split into large (1 million residents or more) and other (less than 1 million residents) categories. The movement of both the elderly and the nonelderly from the North to the South and West is again evident here in the declines over the three decades in the concentration of persons residing in the North

TABLE 9-2 Division of Residence of Total and Elderly (65 and over at census year) Migrants by Division of Residence 5 Years Earlier: 1975-1980

Region of Residence in 1975	Region of Residence in 1980: New England	Middle Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific	Total
New England										
Total	—	22.7	9.4	3.3	32.1	2.8	6.7	7.4	15.7	100.0
Elderly	—	10.7	3.1	1.2	64.4	1.3	2.5	6.0	10.6	100.0
Middle Atlantic										
Total	12.2	—	11.0	2.8	43.2	3.0	7.3	7.2	13.4	100.0
Elderly	6.9	—	4.4	0.9	68.4	1.9	2.9	5.5	9.0	100.0
East North Central										
Total	3.1	7.5	—	11.8	26.1	11.2	12.7	12.1	15.6	100.0
Elderly	1.0	3.3	—	6.0	46.2	8.6	8.7	13.9	12.4	100.0
West North Central										
Total	1.9	3.7	21.6	—	11.1	4.3	20.8	19.5	17.2	100.0
Elderly	0.7	1.5	13.9	—	14.3	3.4	22.1	24.1	20.0	100.0
South Atlantic										
Total	6.3	17.9	17.5	5.4	—	17.1	15.2	7.0	13.5	100.0
Elderly	6.7	22.8	20.4	4.0	—	15.8	9.8	7.4	13.1	100.0
East South Central										
Total	1.6	4.1	22.9	5.3	33.4	—	20.3	4.4	8.0	100.0
Elderly	1.1	3.2	24.4	4.0	40.3	—	16.4	4.0	6.6	100.0
West South Central										
Total	2.2	4.6	12.2	13.4	17.1	12.3	—	16.7	21.4	100.0
Elderly	1.5	2.9	10.1	13.6	16.6	14.0	—	18.3	23.1	100.0
Mountain										
Total	2.1	4.3	9.7	12.9	8.6	2.6	18.3	—	41.4	100.0
Elderly	1.5	2.8	8.6	12.6	8.2	2.2	18.0	—	46.0	100.0
Pacific										
Total	3.7	6.4	11.0	9.6	13.9	4.0	17.8	33.6	—	100.0
Elderly	1.9	3.7	8.1	11.0	11.6	3.8	18.1	41.7	—	100.0

SOURCE: Rogers (1992a).

TABLE 9-3 Change in Distribution of Elderly Populations Across Region and Metropolitan Categories, 1960-1970, 1970-1980, and 1980-1990

Region and Metropolitan Categories	Distribution				Change in Distribution		
	1960	1970	1980	1990	1960-1970	1970-1980	1980-1990
Elderly population North							
Large metro	30.6	29.8	26.9	25.5	-0.8	-2.9	-1.4
Other metro	12.4	11.6	10.9	10.7	-0.8	-0.7	-0.2
Nonmetro	14.9	13.3	12.3	11.2	-1.6	-11.0	-1.1
South							
Large metro	6.6	8.1	9.3	9.7	1.5	1.2	0.4
Other metro	9.2	10.3	11.7	12.8	1.1	1.4	1.1
Nonmetro	11.7	11.5	12.1	11.6	-0.2	0.6	-0.5
West							
Large metro	9.4	10.0	10.6	11.3	0.6	0.6	0.7
Other metro	2.5	2.7	3.3	3.8	0.2	0.6	0.5
Nonmetro	2.6	2.6	3.0	3.4	0.0	0.3	0.4
Total	100.0	100.0	100.0	100.0			
Nonelderly population North							
Large metro	30.8	30.4	27.0	25.3	-0.4	-3.4	-1.7
Other metro	11.7	11.5	10.9	10.3	-0.2	-0.6	-0.5
Nonmetro	11.0	10.0	9.7	9.1	-1.0	-0.3	-0.6
South							
Large metro	8.1	9.3	10.3	11.3	1.2	1.0	1.0
Other metro	11.5	11.6	12.5	12.8	0.1	0.9	0.3
Nonmetro	11.2	9.9	10.3	10.0	-1.3	0.4	-0.3
West							
Large metro	9.9	11.3	12.2	13.6	1.4	0.9	1.4
Other metro	3.0	3.3	4.0	4.4	0.3	0.7	0.4
Nonmetro	2.8	2.7	3.2	3.3	-0.1	0.5	0.1
Total	100.0	100.0	100.0	100.0			

SOURCE: Frey (1992b).

and in the rise of the percentages of persons residing in the South and West. Thus, the shares of both the elderly and the nonelderly living in the South and the West steadily increased over this period, while the shares of both groups living in the North declined.

When examined in terms of trends in metropolitan/nonmetropolitan distribution patterns, these data also reveal an interesting divergence in redistribution patterns between the elderly and nonelderly. The decade of the 1970s marked a lessening (and in certain instances, reversal) of a longstanding trend toward concentration of the U.S. population in metropolitan areas (Frey and Speare, 1988; Fuguitt et al., 1989). The fraction of the population living in nonmetropolitan areas (small cities, towns, and rural areas) began to increase, with most of this growth occurring in the South and West. Both the elderly and the nonelderly contributed to this change, although in the case of the elderly the break with the 1960s pattern of increasing metropolitan population concentration was not as sharp as it was for the nonelderly. The elderly in the 1960s were already showing signs of nonmetropolitan redistribution tendencies, leading to the "nonmetropolitan turnaround" that manifested itself among both groups in the 1970s. However, the turnaround apparently lost momentum in the 1980s as tendencies toward greater metropolitan concentration reemerged. But during the 1980s the elderly once again seem to be diverging from the dominant pattern, showing less of a tendency toward metropolitan growth than the nonelderly, particularly in the case of the West region (Fuguitt and Beale, 1993).

What types of migration behavior contribute to these redistribution patterns? The increasing concentrations of both elderly and nonelderly in the South and West, and the decreasing concentrations in the Northeast and Midwest, derive by definition mostly from interstate migration. But this is not the only kind of movement measured by the Bureau of the Census in government surveys. County-to-county movement within the same state, which contributes to metropolitan redistribution, is also assessed, as is movement within the same county (usually referred to as residential rather than geographic mobility). Examination of the percentage of the population reporting a move during the previous year of each of the three types (between states, between counties within a state, and within counties) for each of three time periods (1966-1971, 1982-1983, and 1990-1991: we report averages for a 5-year interval for the first time period because this was what the Census Bureau was able to provide us) reveals two major patterns. First, a similar age pattern of mobility is evident for all three types (Figure 9-1). Regardless of type of move, the percentage reporting a move in the previous year is three to four times as large for persons in their twenties as for the elderly (Long, 1988). Thus, even though geographical redistribution is a significant phenomenon among the elderly, it involves much less movement than occurs among the nonelderly.

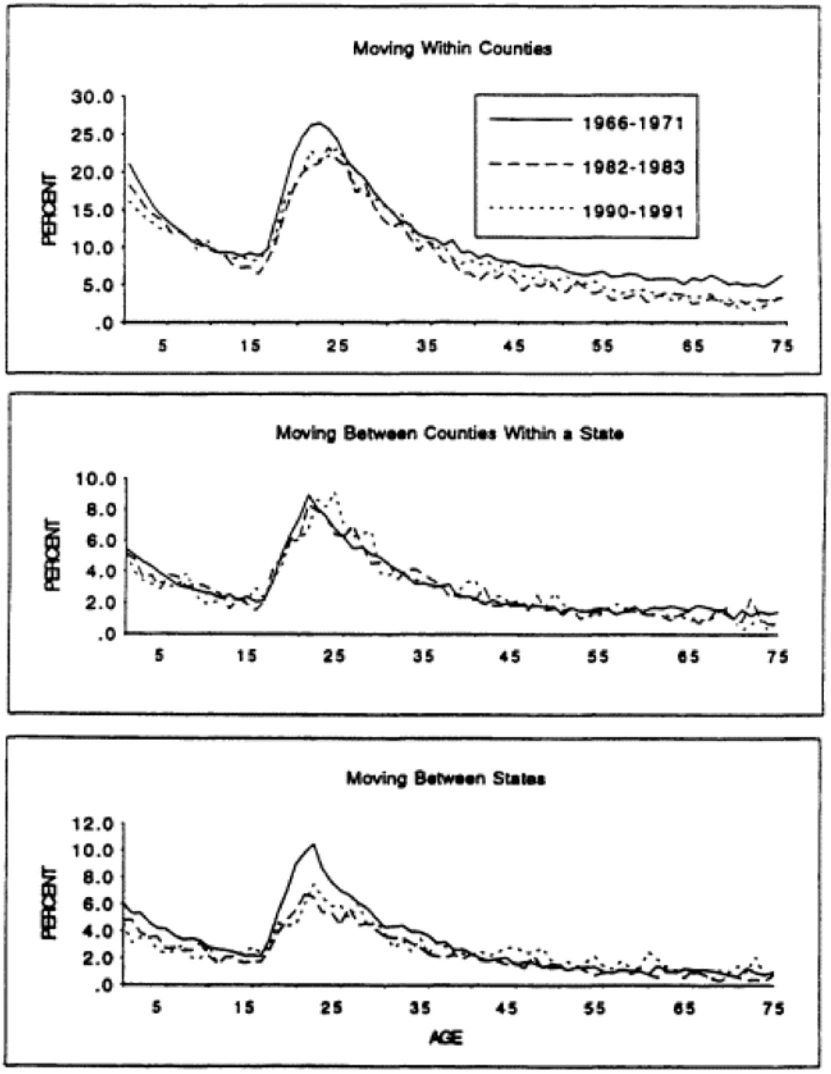

Figure 9-1 Percentage of U.S. population moving within counties, between counties within a state, and between states, by age: March 1966-March 1971, March 1982-March 1983, and March 1990-March 1991.

Second, the percentages reporting moves have declined over time. However, in the cases of the two types of moves with the greatest implications for regional or metropolitan population redistribution (interstate and intercounty moves within a state), the declines were concentrated among persons in their twenties. Beginning at about age 40, the graphs are virtually identical, indicating that the percentage of elderly making these kinds of moves remained relatively undisturbed between the time periods. This pattern is significant because it implies that the nature and the magnitude of forces governing the migration behavior of the elderly and the settled working-age population (ages 40-64) have remained similar over this time, while the forces affecting the migration behavior of the younger working-age population (ages 20-39) have changed. Although the propensity to migrate among the elderly is much lower than it is among the working-age nonelderly, it does not decline uniformly with age. Rather, small blips occur around age 65 (probably as a result of retirement moves) and around ages 75-79 (probably reflecting moves associated with declining health) (Rogers, 1992b; DeAre, 1992). As we note below, patterns such as this have led to the formulation of life-course conceptualizations of elderly migration that envision the likelihood of elderly movement tied to significant changes in life situation (Litwak and Longino, 1987).

MIGRATION RESEARCH

The previous sections have examined patterns of geographic distribution of the older population in the United States and how these patterns have changed over time. The migration of both the younger and the older segments of the population affects these patterns. The present section turns to the questions of why certain migration patterns have taken place and why they have changed over time. The examination begins by considering some of the factors at the aggregate or macrolevel that may induce or hinder population redistribution. Then it turns to individual-level or microfactors. Macro- and microlevel factors also interact in their effects on migration, as the following discussion points out.

The Macrolevel of Explanation: Location-Specific Amenities and Their Interactions

The demographic literature on migration is replete with discussions of factors within a given area that discourage or encourage persons to leave the area in search of residence elsewhere, such as poor economic conditions, changing technology, or ethnic/racial discrimination (see, for example, Stinner and De Jong, 1969; Greenwood, 1975, 1985). Similarly, lists of factors that may attract migrants to a specific area, or incline them to choose one area versus another, once they have decided to leave their area of origin, have also been compiled. Earlier demographic literature refers to these as "push" and "pull" factors (Heer, 1963; Lee, 1966). More recently, especially among economists working in this area, these discussions have been framed in terms of labor market opportunities and "location-specific amenities" (Greenwood and Hunt, 1989). Often these factors are discussed in conjunction with (or matched up with) characteristics of the migrants. For example, a young adult, whose major reason for migration is tied to her or his economic situation, may leave a given area because of unemployment or because, although employed, the individual seeks a better or more desirable job (Greenwood and Hunt, 1989). Thus, for the younger population, such characteristics of an area as poor labor market conditions (including old or declining industries) may "push" or motivate persons to move to another area where they may find a better match or fit to their specific characteristics (Da Vanzo, 1981). Prevailing conditions in land and housing markets, availability of other public goods such as education and health care, cultural amenities, climate, and other environmental aspects of an area (temperature ranges, seashores, mountains, etc.) can all enter into decisions to move or not to move (Greenwood and Hunt, 1989).

When considering characteristics of an area that may attract older migrants (or motivate them to depart), the same kinds of characteristics must be considered, but the particular combination of these factors, along with the relative weights of the factors in terms of explanatory importance, may be quite different. For example, for a young household head with high levels of human capital (e.g., good education, good employment history), a labor market with ample employment opportunities for persons seeking high-wage jobs in a variety of sectors of the work force may be very attractive. For an older couple with the household head approaching retirement and strong interests in carefully shepherding economic resources, the most attractive package of economic amenities may look rather different. An area that has a lower cost of living—including a lower wage structure, especially in the service sector (Longino, 1990), and lower taxes—may be much preferred to a higher-wage (and consequently higher cost of living) labor market (Serow et al., 1986). This older household is more likely to be paying for services to help maintain a home and a certain standard of living. Its members thus may be much less interested in seeking high wage, long-term employment (Fournier et al., 1988).

The industrial structure of a local labor market is thus not irrelevant for the migration behavior of either the young or the old; rather different sets of factors become attractions for different age sectors of the population. For example, King (1978) has found that a local labor market with an industrial structure having a relatively large number of jobs that offer part-time and/or flexible work hours has higher labor force participation rates for women, especially those with young children at home. It may also be the case that a local labor market with an industrial composition that provides an abundance of part-time jobs of the kind that a healthy older population can compete for, could conceivably become a powerful draw for healthy retirees, especially those on fixed retirement incomes who worry about the potential loss of economic security in the future. In sum, the relationship between the economic structure of local areas and migration, which is considered to be quite strong at the young adult ages, must still be considered as a potential determinant of migration for the older population. The specific aspects of the local labor market, however, and the relative weight each factor plays in the final decision to move (as well as precisely where to move) may be quite different.

Similar considerations may apply in the cases of other location-specific amenities. The importance of climate (i.e., warmer weather) is often mentioned regarding elderly migration. (It should be clear, however, that the increase in concentration of elderly in the Midwest and New England is not due to this factor, but rather to outmigration of the nonelderly and aging-in-place as mentioned above.) Other aspects of the local area, especially the availability of health care services and facilities (including the ability to pay for these services—see Marshall et al., 1989), become increasingly important. There are also the special cases of retired military populations that often appear to concentrate in the vicinity of military bases for PX privileges and near Veterans Administration hospitals for the availability of medical services.

The discussion of push-pull factors in interregional migration in the case of the young adult (and/or economically active) population often takes place in the context of equilibrium or disequilibrium models. Within this kind of framework, when differential wage rates across regions are assumed to constitute equilibrium or compensating differentials, they presumably do not directly encourage interregional migration. Various economic factors such as income, however, may work rather differently for young adults and the elderly. A relatively high level of household income may deter migration at younger ages, but it appears to promote migration at retirement ages (Hogan, 1987; Longino, 1990). Graves and Linneman (1979) distinguish between "traded" and "nontraded" goods in their discussion of individual utility functions for migration. Changes in demand for nontraded goods cause migration, since the only way for a household to satisfy its changed demand for nontraded goods is relocation. One example of how this may affect elderly migration is that as retirement age approaches, the household's "demand" for better climatological and environmental factors may increase vis-à-vis other factors (such as a stable, well-paying job). Similarly, as a number of researchers have suggested, if the desire to be close to family, friends, and relatives is an increasingly important determinant of potential migration with increasing age, this particular "nontraded" good (i.e., family network ties) may become a strong (and sometimes countervailing to environmental) factor in determining migration decisions (Da Vanzo, 1981).

Studies have also found an increase in elderly migration from urban to rural areas. In fact, the migration of the elderly from metropolitan areas contributed substantially to the growth of nonmetropolitan areas during the 1970s and, to a lesser extent, the 1980s (Lichter et al., 1981; Longino, 1982; Fuguitt and Beale, 1993). These long-distance moves may be motivated by the desire to return to areas of origin or to be closer to family and friends. Another trend in migration among the older population is that moves increasingly tend to cover relatively long distances (Serow and Charity, 1988). As Myers (1985:194) points out, "These developing trends in the movement of older persons are bringing a greater diversity in their patterns of residence. The result is the redistribution of the aged to areas that are more suitable environmentally, a shift that calls attention to emerging needs for new amenities and services." More research focusing specifically on the preferences and motivations of older persons from various subgroups of the population will be necessary before we begin to clearly understand how age interacts with personal and structural factors such as distance to influence different types of moves.

The changing patterns in the spatial distribution and concentration of the elderly are thus determined in large part not by what happens to the elderly but by what determines the migration and redistribution patterns of the nonelderly population. Although we have commented on factors that may promote movement of the older population from one area to another, and pointed out that the factors determining migration among the elderly are substantially different from those in the younger population, these factors are often overwhelmed by the sheer magnitude of migration streams involving the nonelderly population (Frey, 1986). Explaining migration among the elderly is a challenging task, and one in which there is still much to be accomplished. But that task is almost by definition incomplete without a consideration of migration across the entire spectrum of the age distribution.

Elderly population increase in either a relative or an absolute sense also exerts macrolevel consequences. To the extent that increasing concentrations of the elderly, and especially the oldest-old, are achieved through aging-in-place rather than migration, the demand for and provision of social and health services may be affected. Given that retirement-age elderly migrants are on average more likely to be married, have higher incomes and more education, and to be healthier than the nonmigrant segment of the elderly population (Biggar, 1980; Speare and Meyer, 1988), the areas that achieve concentrations of elderly through aging-in-place may require more health services, and concentrate a more substantial drain on local govern ments (on a per capita elderly basis), than areas where the concentrations of the elderly population have been achieved through inmigration.

The Microlevel of Explanation: Individual and Household Characteristics and the life-cycle

During the latter stages of the life course, migration can serve several functions, including allowing aged individuals to improve the quality of their physical and social environments, and providing them with supportive institutional care as the quality of health declines. Thus, residential moves in later life have been conceptualized as following an ideal typical sequence consisting of three stages (Litwak and Longino, 1987; Speare and Meyer, 1988). In the first stage, a typical retiree is thought to move while still relatively young in order to maximize environmental and life-style amenities. A second, later stage of change is seen as motivated by the desire to be closer to family and kin as health begins to deteriorate. Finally, a third stage of movement, often to institutions offering long-term care, is seen as dictated by increasing physical incapacities.

Such an ideal-typical sequence is useful analytically to the extent that the elderly follow similar patterns of physical decline and to the degree that the motivations and desires at the three stages are relatively homogeneous among older individuals. However, as recent data make clear, neither declines in health nor changes in living arrangements closely follow any prescribed universal sequence (Manton, 1988; Angel et al., 1992; Worobey and Angel, 1990a). As with other life-course transitions that involve school completion, employment, and fertility (e.g., Rindfuss et al., 1987), migration among the elderly is characterized by a great deal of heterogeneity in both the patterns of and the motivations for residential changes. As of yet, our understanding of the motivations for and patterns of residential changes in later life is insufficiently developed—especially in reference to subgroups of the population such as blacks, Hispanics, or those over the age of 85—to provide a firm indication of the degree to which conceptualizations of elderly migration stages correspond to actual patterns of behavior.

Empirical investigations of migration decisions in later life must also be informed by sound theoretical models of the psychological factors that motivate individuals to move and the structural factors that constrain their choices. From a simple utility-maximizing notion, or from the perspective of some hedonistic calculus that individuals seek to make themselves most comfortable, we can assume that the migration decisions of older individuals are influenced by their desire to maintain or improve the quality of their lives. Whereas younger people move for educational and occupational reasons (e.g., labor market-related reasons), older persons move because of poor health, to reduce their cost of living, to be closer to family, and to find a more comfortable physical environment (De Jong and Fawcett, 1981; De Jong et al., 1992; Golant, 1980). Empirically, we know that migration in old age is correlated with a large array of social and demographic characteristics, including age (Golant, 1980); family structure (Bradsher et al., 1992); number of living adult children (Spitze et al., 1992); proximity to family, friends, and relatives (Cornwell et al., 1992; Lee et al., 1990); health and economic constraints (Baglioni, 1989; Speare et al., 1991; Longino et al., 1984; Burr and Mutchler, 1992; Worobey and Angel, 1990a,b); and the availability of recreational facilities (Steinnes and Hogan, 1992).

Explanations for these associations are encompassed in the theoretical or ideal-typical models noted above. Although many such models are consistent with the data, almost all have in common a distinction among different reasons for moving. A number of studies have pointed out that there are two basic kinds of elderly moves: those that are voluntary, which occur so that the elderly can improve the quality of their lives, and those that occur out of necessity. Voluntary migrants may be viewed as trying to maximize personal control over their lives in seeking an improved quality of life and amenities (Longino and Smith, 1991; Wiseman, 1980; Wiseman and Roseman, 1979). These individuals come closest to achieving the ideal image of retirement, one filled with the relaxation, freedom, and rewards earned after a lifetime of productive work. Voluntary migrants are often economically secure and move as part of the retirement process (Longino, 1990). Migrants who move out of necessity, as the phrase implies, do not exercise such autonomy. Their moves are necessitated by poverty, poor health, or the need for assistance with activities of daily living (ADLs). These individuals tend to be older, female, economically disadvantaged, poorly educated, and single (Longino, 1990). The motivations for the two types of migration are different and have important implications for understanding the migration process.

Considerable diversity thus exists not only in patterns of residential change in later life, but also in individual motivations for moves. Recent evidence from the 1990 Longitudinal Study of Aging (LSOA) confirms substantial heterogeneity in motives for migration in old age (De Jong et al., 1992). This survey contains a 6-year follow-up of persons who were 70 years and older when originally interviewed in 1984 as part of the Supplement on Aging to the National Health Interview Survey (NHIS) (Kovar et al., 1992). Between 1984 and 1990, 930 (16 percent) of the surviving residents reported making at least one move while 4,883 said they had not moved. At the follow-up, approximately one-fifth of the respondents who moved reported that they did so because of a desire to live closer to or with their family; another one-fifth moved for such amenities as better weather and neighborhood; and yet another one-fifth moved because of diminished health of the elderly person him or herself, or that of his or her spouse. Of the remaining two-fifths, numerous reasons led to the move, including factors such as economic constraints (e.g., less expensive house to maintain), and changes in marital status.

Another group of studies has more explicitly examined the second and third types of moves noted above, also using data from the LSOA. Based on the 1984-1986 wave, Zimmerman et al. (1993) showed that individuals age 70 and older who have suffered moderate declines in instrumental activities of daily living (IADL) are more likely to change their residence than those who have not, although the perceived proximity of someone to provide assistance with household chores reduced the likelihood of a move taking place. What these data suggest, then, is that the availability of kin rather than economic resources allows the elderly to stay in their current residence in the event of a significant decline in IADL. Speare and his colleagues (1991) reach a similar conclusion in their analysis of changes in living arrangements.

Similarly, Worobey and Angel (1990a), employing the 1984-1986 wave of the LSOA, found that unmarried older individuals who experience a substantial decline in functional capacity are more likely to enter a nursing home than those who suffer no decline. At the same time, the great majority of older singles continue to live alone even when faced with significantly diminished health, suggesting substantial variations in patterns of geographic mobility. In addition, the LSOA studies demonstrate the impact of numerous other variables, including race and ethnicity, on patterns of living arrangements, suggesting that any simple typology of reasons for moving may oversimplify the reality faced by older adults. Eventually the tripartite typology of the reasons for migration in later life may become more elaborate in light of the variety of preferences and constraints faced by older people in contemplating residential changes.

INTERNATIONAL COMPARISONS

The chapter has focused, to this point, on research on the population distribution and internal migration of older persons in the United States. Although the chapter by Martin and Kinsella in this volume addresses international issues in aging research, specific attention to the extensive work on cross-national comparative research on the subject of internal migration merits separate consideration.

A major intent of comparative analyses in the field of demography is to establish whether or not commonalities exist across countries in population structures and in the forces, including underlying behavioral factors, that bring them about. Moreover, explicit efforts are often directed at conceptualizing general historical processes of cultural, societal, and developmental change, especially demographic transitions that take place through identifi able stages. The formulation of such models enables demographers to classify countries according to where they fall along some underlying temporal process. The theory of the demographic transition is an example of a perspective that facilitates generalizations about seemingly universal transformations in vital rates (birth and deaths) and their effects on population structures, such as population aging. The formal properties of population aging and its structural consequences are nicely formulated by Lee in this volume.

Similar efforts have been undertaken to generalize about geographic distributions and characteristic patterns of redistribution of populations within countries, notably in the case of the processes of urbanization that accompany demographic transitions. In addition, interest has been growing in examining the geographic distributions and redistributions of *older* persons and the forces contributing to these spatial patterns. As noted earlier in this chapter, the components of change in such areal concentrations, especially for specific subpopulations such as the elderly, are rather complex. They involve for specific geographic units not only net elderly aging-in-place and net elderly migration, but also the natural increase and net migration of the nonelderly. Empirical studies of these components on a comparative basis have been rather limited until recently by the lack of adequate time-series data, especially for developing countries. Nonetheless, several stylized depictions of transitions of changing concentrations of older persons and the mobility component have been undertaken (Law and Warnes, 1982; Myers and Clark, 1991; Rogers, 1989).

There are several fundamental processes that must be taken into account in deriving generalized temporal patterns of elderly redistribution and migration: (1) The size, growth, and relative share of any older population tend to increase during the course of the demographic transition, subject to historic fluctuations in natural increase. (2) The pace of change in levels of fertility and mortality tends to vary among geographic areas, for example, between rural and urban areas. (3) The shift from agricultural to manufacturing- or commerce-based economies leads to concentrations of these activities in cities and concomitant urbanization. (4) The propensity for internal movement tends to rise in the process of demographic transitions, but may level off or even decline as population stabilization occurs (Haag et al., 1988). Propensities to move can vary among countries, perhaps reflecting sociocultural factors. (5) There exist fairly general *age* patterns of geographic mobility that are largely determined by life-course transitions (Warnes, 1992). Moreover, the timing of life-course events may change due to sociodemographic and societal factors. (6) Associated with these age patterns are characteristic patterns of spatial movement and of the distance of moves (Stillwell, 1991).

Urban and Rural Patterns

Kinsella and Taeuber (1993) and Myers and Clark (1991) have noted that the share of a country's elderly population living in rural areas is greater than that in urban areas in most developing countries, with the exception of several heavily urbanized countries of Latin America. Nonetheless, the overall trends leading to increased urbanization in most countries characterize the aged population as well. Whereas two-thirds of the elderly population in developing countries currently live in rural areas, this figure is projected to be less than 50 percent by the year 2015 (United Nations, 1991). In developed countries, nearly three-fourths of the older population live in urban areas, and this is expected to reach 80 percent over the same time period.

The proportion of older persons tends to be greater in the population of rural areas than of urban areas in the developing countries of Africa and Asia, but also in some European countries. The opposite is true in Canada, the United States, Australia, New Zealand, and several Latin American countries. Time-series analyses indicate that in the process of development, the higher concentrations of older persons in rural areas gradually shift to higher concentrations in urban areas. This reflects the importance of aging-in-place that initially affects rural areas as heavy nonelderly movement to urban areas occurs, then gradually shifts toward aging-in-place in urban areas as rural-to-urban migration abates. For the most economically advanced countries, yet another reversal has been noted in which the migration of older persons from urban to rural areas occurs. These patterns suggest that a series of stages in elderly concentrations can be posited, depending both on dominant migration flows of the elderly and the nonelderly and on relative patterns of natural increase.

Another interesting feature of elderly population distribution in developing countries has been the higher concentration of older males in rural areas and older females in urban areas. This is true of most developed as well as developing countries. An explanation for this counterintuitive finding may rest in the migration of rural women, particularly widows, to urban places to rejoin children who have moved earlier in life. More extensive research is needed on this pattern because it holds profound implications for the housing and service requirements of urban areas, especially among older women. Foreign studies have also paid attention, in both developing and developed countries, to the temporary nature of moves among older persons. The periodic sharing of households with offspring of older persons has been noted in China and Indonesia (Goldstein et al., 1991; Hugo, 1987). In developed countries such as the United States, a circularity of moves may reflect temporary residence in multiple homes that older persons own. More research on temporary migration is also needed.

Developed Country Patterns

A major comparative Migration and Settlement Study conducted at the International Institute for Applied Systems Analysis between 1976 and 1982 drew attention to the general *age* patterns of migration that characterized 17 industrialized countries (Rogers and Willekens, 1986). Among the features of these patterns was the increased likelihood of longer-distance migration associated with the needs for support and assistance. Building on a earlier model proposed by Law and Warnes (1982) and focusing on retirement-type movement, Rogers (1989) has proposed a set of typical stages referred to as the "elderly mobility transition." A first stage reflects early industrialization characterized by low levels of retirement moves from urban areas back to widely dispersed rural areas of origin. A second stage reflects higher levels of retirement moves to selective destinations that offer attractive environmental opportunities (i.e., climatic conditions). In postindustrialized societies, a third stage emerges with more diffuse destinations in nonmetropolitan areas that may often be closer to places of origin.

An International Elderly Migration Project conducted in the late 1980s enabled Rogers and a network of international scholars to assess this model of elderly migration and population redistribution. Rogers et al. (1990) report countries classified by stages, with the United Kingdom clearly in the final stage, the United States approaching it, and Japan and Italy probably still in the first stage. Nonetheless, pervasive regularities in age-migration profiles were found to characterize the situation in all of the countries, and some spatial patterns also emerged. The studies from this project and others conducted in England and France (Noin and Warnes, 1987) have all identified amenity movement at retirement ages as a more important factor than aging-in-place in leading to spatial concentrations of aged persons in advanced industrialized countries. These concentrations are often located in nonmetropolitan areas, especially on coastlines that offer favorable climatic conditions and recreational opportunities. Important covariates have been reported in these comparative studies. In the case of older elderly persons, the unmarried are more likely to move than married persons. In particular, this is true of widowed persons, which leads to higher propensities of female than male movement at later ages. In the case of younger elderly persons, those with higher education and greater financial resources also are more likely to move.

There has also been increasing examination of the consequences of elderly movement for the older movers, their families, and the communities of origin and destination. In particular, the implications of elderly movement for areas of destination, especially areas of high concentrations, are coming to be examined more extensively with respect to such factors as housing and infrastructure (e.g., services for the elderly). Considerable research in France and England (Noin and Warnes, 1987) on these topics should serve to stimulate similar interest in the United States.

In spite of the efforts that have been made to generate models of typical sequences of elderly population redistribution and migration flows, along with changing levels of elderly migration propensity, it is still the case that comparative research shows that considerable intercountry variability exists. Notwithstanding the difficulties inherent in studying these phenomena cross-nationally, which arise from varying geographic units of analysis and definitions of migration, the general features of the temporal model of transitions seem to hold for many industrialized countries.

KNOWLEDGE GAPS AND DATA NEEDS

As the populations of the United States and other countries have aged, it has become increasingly evident that the distribution and redistribution of the elderly population entail important public policy consequences. Jurisdictions that contain above-average concentrations of the elderly are faced with planning and policy requirements that are different from those of areas with lower concentrations of the elderly (such areas, of course, may face similar policy and planning imperatives when the absolute sizes of their elderly population are large). Substantial net inter-area transfers of the elderly have implications for population growth, age structure, and the provision of health and social benefits. Although the demographic, economic, and public policy significance of migration and population redistribution among the elderly has grown increasingly clear, this importance has yet to be matched by research output focusing on some of the issues that have emerged.

Two major gaps in knowledge in particular warrant comment. The first concerns demographic components of change in aging and their consequences. Although some empirical knowledge has been marshaled concerning the magnitude of the net migration and aging-in-place components of population aging (Fuguitt and Beale, 1993; Rogers and Woodward, 1988), little systematic empirical evidence has been assembled concerning the magnitude of the subcomponents of these, especially at the subnational (regional, state, metropolitan area) level. Geographic convergence in fertility and mortality patterns over time, together with the relatively low levels of immigration to the United States until recently, implies that the magnitude of the subcomponents will vary according to the level of analysis, with internal migration making a greater difference for the concentration of the elderly at the state level than international migration makes at the national level. But to understand better the consequences of these demographic changes, more information is needed about how much difference various demographic factors make for population aging, especially at subnational levels of geography.

We also need to know more about the consequences of population aging for the health and social service costs of states and cities. It is evident that aging has implications for these costs, but again, to our knowledge, little research has been conducted into the quantitative impact of population aging for state- and city-level changes in health and social service costs. By the same token, research is lacking on how much difference the various components of population aging (including the age pattern of net migration) make for changes in net public benefit costs. In fact, Longino (1990) notes that many observers assume that the growing concentration of the aged in an area has negative social and economic consequences, a notion he terms the "gray peril mythology." Recent research suggests that the growth of the aged in a given area often exerts positive benefits, especially if it results from the inmigration of affluent younger-old (aged 65-74) retirees (Biggar, 1980; Longino, 1988; Haas and Crandall, 1988). But if the nonelderly move away from an area, leaving the elderly behind, the economic implications may be more adverse. Research does not presently exist that quantifies relationships across areas in differences in the various components of population aging and differences in elderly public benefits, or relationships between changes in the demographic components of aging and changes over time in the receipt and expenditure of tax dollars on programs that benefit the elderly.

Information is also needed concerning the degree to which the magnitude of the various demographic components of aging may be changing. The effects of immigration, for example, seem unlikely to remain small as they have been in the past. At a national level, immigration has not yet contributed much to population aging (Preston et al., 1989), primarily because its volume has been relatively low (at least until recently) and because the median age of immigrants tends to be slightly lower than that of the general population and the distribution of immigrants' ages tends to be narrower (Arthur and Espenshade, 1988). However, states vary enormously in the percentages of their populations that are foreign born, with California (21.7 percent), New York (15.9 percent), and Florida (12.9 percent) showing the highest concentrations (Bureau of the Census, 1992a). As these foreign-born populations age, their health and social service needs may differ from those of other elderly. Whatever the case, it would be useful to know how relationships between the demographic components of aging and the relative balance of tax and public benefit dollars vary across locales and change over time.

The second major gap occurs at the level of individual migration behavior. The lack of detailed longitudinal data about migration, retirement, and health has prevented to this point the adequate testing of hypotheses devel oped within a life-course framework about linkages between migration and the occurrence of retirement and health events. The patterns that have emerged in aggregate data provide a basis for developing hypotheses that transitions in living arrangements occur because individuals seek environments that are compatible with age-influenced needs, desires, and goals. In this perspective, residential change is thought to be linked to the timing and sequencing of age-related role changes and significant life events (Lee, 1980). Individuals are more likely to move with their families prior to the teen years. Adolescent children are more residentially stable. During early adulthood, individuals move again as a normal life-course transition as they seek employment, marriage, and parenthood. After these early life transitions occur, greater residential stability characterizes the adult years between 25 and 65. Although moves occur, they are less frequent and less tied to age-related life events. Retirement, however, may again give more weight to age-related reasons for residential change. Older individuals move in response to leaving the labor force, as the result of losing a spouse, or because of declining functional capacity (Golant, 1980).

As noted earlier, the kinds of residential moves among the elderly have been arranged in a typological sequence consisting of (1) moves intended to maximize life-style and amenities, (2) moves intended to bring one closer to family, and (3) moves dictated by declining health (Litwak and Longino, 1987). Although research on the determinants of living arrangements and changes in residential patterns among the elderly has increased in recent years, hypotheses linking reasons and motives for migration to patterns of residential change among the elderly need more systematic testing at the individual level of analysis. As yet, for example, we do not know whether older persons who suffer a serious decline in functional capacity and who require assistance with ADLs are more likely to move closer to their adult children than elderly who are functionally independent. Recent analyses of the third wave of the LSOA suggest that elderly persons who move out of state may have done so in anticipation of deteriorating health. These data provide some evidence that older persons do in fact move closer to their families prior to suffering serious declines in functional capacity (Angel et al., 1991), suggesting that the availability of kin may be one of the most important predictors of migration in later life (e.g., Krout, 1988; Clark and Wolf, 1992).

Recent studies have also begun to examine the impact of changes in functional status on the likelihood of residential mobility for aged men and women, and for whites and blacks. This research should be extended to examine the interaction of race, gender, and locational factors in the probability of specific types of migration, including the likelihood of entering assisted-living facilities or nursing homes. It is hoped that the new national longitudinal Health and Retirement Survey that is currently under way will provide the kinds of detailed life history data that will allow stronger inferences to be drawn about causal relationships between life events and migration behavior among the elderly.

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APPENDIX

Number (in 1,000s), Percentage, and Percent Change of Persons 65 and Over, 85 and Over, and Median Age in the United States by Region, Division, and State, 1980-1990

	65 and Over			85 and Over			
Region	1980	1990	Percent Change	1980	1990	Percent Change	Median Age, 1990
U.S. total	25,549 (11.3)	31,242 (12.6)	22.3 (11.5)	2,240 (1.0)	3,080 (1.2)	37.5 (20.0)	32.9
Northeast	6,071 (12.4)	6,995 (13.8)	15.2 (11.3)	547 (1.1)	710 (1.4)	29.9 (27.3)	34.2
New England	1,520 (12.3)	1,770 (13.4)	16.4 (8.9)	151 (1.2)	194 (1.5)	28.3 (25.0)	33.7
Maine	141 (12.5)	163 (13.3)	15.9 (6.4)	14 (1.3)	18 (1.5)	29.3 (15.4)	33.9
Vermont	58 (11.4)	66 (11.8)	13.7 (3.5)	6 (1.2)	8 (1.3)	25.2 (8.3)	33.0
New Hampshire	103 (11.2)	125 (11.3)	21.4 (0.9)	10 (1.0)	13 (1.2)	37.7 (20.0)	32.8
Massachusetts	727 (12.7)	819 (13.6)	12.8 (7.1)	74 (1.3)	92 (1.5)	24.8 (15.4)	33.6
Rhode Island	127 (13.4)	151 (15.0)	18.6 (11.9)	12 (1.3)	16 (1.6)	33.7 (23.1)	34.0
Connecticut	365 (11.7)	446 (13.4)	22.2 (16.2)	36 (1.1)	47 (1.4)	31.5 (27.3)	34.4
Middle Atlantic	4,551 (12.4)	5,225 (13.9)	14.8 (12.1)	395 (1.1)	516 (1.4)	30.5 (27.3)	34.4
New York	2,160 (12.3)	2,364 (13.1)	9.4 (6.5)	193 (1.1)	248 (1.4)	28.6 (27.3)	33.9
New Jersey	860 (11.7)	1,032 (13.4)	20.0 (14.5)	72 (1.0)	96 (1.2)	32.3 (20.0)	34.5
Pennsylvania	1,531 (12.9)	1,829 (15.4)	19.5 (19.4)	130 (1.1)	172 (1.4)	32.2 (27.3)	35.0
Midwest	6,692 (11.4)	7,749 (13.0)	15.8 (14.0)	649 (1.1)	840 (1.4)	29.3 (27.3)	33.0
East North Central	4,493 (10.8)	5,299 (12.6)	17.9 (16.7)	415 (1.0)	539 (1.3)	29.8 (30.0)	32.9
Ohio	1,169 (10.8)	1,407 (13.0)	20.3 (20.4)	108 (1.0)	138 (1.3)	27.3 (30.3)	33.3
Indiana	585 (10.7)	696 (12.6)	18.9 (17.8)	54 (1.0)	72 (1.3)	31.9 (30.3)	32.8
Illinois	1,262 (11.0)	1,437 (12.6)	13.8 (14.5)	115 (1.0)	148 (1.3)	28.7 (30.0)	32.8

Number (in 1,000s), Percentage, and Percent Change of Persons 65 and Over, 85 and Over, and Median Age in the United States by Region, Division, and State, 1980-1990

	65 and Over			85 and Over			
Region	1980	1990	Percent Change	1980	1990	Percent Change	Median Age, 1990
Michigan	912	1,108	21.5	82	107	30.9	32.6
	(9.8)	(11.9)	(21.4)	(0.9)	(1.0)	(33.3)	
Wisconsin	564	651	15.4	56	74	33.5	32.9
	(12.0)	(13.3)	(10.8)	(1.2)	(1.5)	(25.0)	
West North Central	2,199	2,450	11.4	235	301	28.5	33.1
	(12.8)	(13.9)	(8.6)	(1.4)	(1.7)	(21.4)	
Minnesota	480	547	14.0	53	69	30.4	32.5
	(11.8)	(12.5)	(5.9)	(1.3)	(1.6)	(23.1)	
Iowa	388	426	9.9	45	55	23.0	34.2
	(13.3)	(15.3)	(15.0)	(1.5)	(2.0)	(33.3)	
Missouri	648	718	10.7	61	81	33.0	33.5
	(13.2)	(14.0)	(6.1)	(1.2)	(1.6)	(33.3)	
North Dakota	80	91	13.2	8	11	38.1	32.4
	(12.3)	(14.3)	(16.3)	(1.2)	(1.8)	(33.3)	
South Dakota	91	102	12.4	10	13	28.0	32.5
	(13.2)	(14.7)	(11.4)	(1.5)	(1.9)	(26.7)	
Nebraska	206	223	8.5	24	29	23.0	33.0
	(13.1)	(14.1)	(7.6)	(1.5)	(1.9)	(26.7)	
Kansas	306	343	11.9	33	42	26.3	32.9
	(13.0)	(13.8)	(6.2)	(1.4)	(1.7)	(21.4)	
South	8,488	10,724	26.3	664	992	49.5	32.8
	(11.3)	(12.6)	(11.5)	(0.9)	(1.2)	(33.3)	
South Atlantic	4,367	5,834	33.6	327	515	57.5	33.7
	(11.8)	(13.4)	(13.6)	(0.9)	(1.2)	(33.3)	
Delaware	59	81	36.4	5	7	35.5	32.9
	(10.0)	(12.1)	(21.0)	(0.9)	(1.1)	(22.2)	
Maryland	396	517	30.8	33	46	42.3	33.0
	(9.4)	(10.8)	(14.9)	(0.8)	(1.0)	(25.0)	
District Columbia	74	78	4.8	6	8	22.9	33.5
	(11.6)	(12.8)	(10.3)	(1.0)	(1.3)	(30.0)	
Virginia	505	664	31.5	41	60	45.2	32.6
	(9.5)	(10.7)	(12.6)	(0.8)	(1.0)	(25.0)	
West Virginia	238	269	13.0	19	25	31.1	35.4
	(12.2)	(15.0)	(12.6)	(1.0)	(1.4)	(40.0)	
North Carolina	603	804	33.3	45	70	54.8	33.1
	(10.3)	(12.1)	(17.5)	(0.8)	(1.1)	(37.5)	
South Carolina	287	397	38.1	20	31	53.7	32.0
	(9.2)	(11.4)	(24.0)	(0.6)	(0.9)	(50.0)	

Number (in 1,000s), Percentage, and Percent Change of Persons 65 and Over, 85 and Over, and Median Age in the United States by Region, Division, and State, 1980-1990

	65 and Over			85 and Over			
Region	1980	1990	Percent Change	1980	1990	Percent Change	Median Age, 1990
Georgia	517 (9.5)	654 (10.1)	26.6 (6.6)	39 (0.7)	57 (0.9)	45.2 (28.6)	31.6
Florida	1,688 (17.3)	2,369 (18.3)	40.4 (5.8)	117 (1.2)	210 (1.6)	79.1 (33.3)	36.4
East South Central	1,657 (11.3)	1,930 (12.7)	16.5 (12.4)	134 (0.9)	186 (1.2)	38.8 (33.3)	32.9
Kentucky	410 (11.2)	467 (12.7)	13.9 (13.4)	35 (11.2)	46 (12.7)	32.3 (30.0)	33.0
Tennessee	518 (11.3)	619 (12.7)	19.6 (12.4)	41 (11.3)	59 (12.7)	41.9 (33.3)	33.6
Alabama	440 (11.3)	523 (12.9)	18.9 (14.2)	34 (11.3)	49 (12.9)	42.6 (33.3)	33.0
Mississippi	289 (11.5)	321 (12.5)	11.0 (8.7)	24 (11.5)	32 (12.5)	37.5 (44.4)	31.2
West South Central	2,464 (10.4)	2,960 (11.1)	20.1 (6.7)	203 (0.9)	291 (1.1)	43.6 (22.2)	31.3
Arkansas	312 (13.7)	350 (14.9)	12.0 (8.8)	26 (13.7)	35 (14.9)	33.6 (25.0)	33.8
Louisiana	404 (9.6)	469 (11.1)	16.0 (15.6)	31 (9.6)	44 (11.1)	42.9 (42.9)	31.0
Oklahoma	376 (12.4)	424 (13.5)	12.8 (8.9)	34 (12.4)	46 (13.5)	34.9 (36.4)	33.2
Texas	1,371 (9.6)	1,717 (10.1)	25.2 (5.2)	112 (9.6)	167 (10.1)	48.7 (25.0)	30.8
West	4,298 (10.0)	5,774 (10.9)	34.3 (9.0)	380 (0.9)	539 (1.0)	41.6 (11.1)	31.8
Mountain	1,061 (9.3)	1,524 (11.2)	43.6 (20.4)	86 (0.8)	133 (1.0)	53.6 (25.0)	31.6
Montana	85 (10.7)	106 (13.3)	25.9 (24.3)	9 (10.7)	11 (13.3)	20.8 (18.2)	33.8
Idaho	94 (9.9)	121 (12.0)	29.4 (21.2)	8 (9.9)	11 (12.0)	34.5 (22.2)	31.5
Wyoming	37 (7.9)	47 (10.4)	27.0 (29.1)	3 (7.9)	5 (10.4)	31.0 (42.9)	32.0
Colorado	247 (8.6)	392 (10.0)	33.2 (16.3)	24 (8.0)	33 (10.0)	35.3 (25.0)	32.5

Number (in 1,000s), Percentage, and Percent Change of Persons 65 and Over, 85 and Over, and Median Age in the United States by Region, Division, and State, 1980-1990

	65 and Over			85 and Over			
Region	1980	1990	Percent Change	1980	1990	Percent Change	Median Age, 1990
New Mexico	116	163	40.7	9	14	62.0	31.3
	(8.9)	(10.8)	(21.3)	(8.9)	(10.9)	(28.6)	
Arizona	307	479	55.8	20	38	89.7	32.2
	(11.3)	(13.1)	(15.9)	(11.3)	(13.1)	(42.9)	
Utah	109	150	37.2	9	14	53.8	26.2
	(7.5)	(8.7)	(16.0)	(7.5)	(8.7)	(33.3)	
Nevada	66	128	94.1	4	7	105.0	33.3
	(8.2)	(10.6)	(29.3)	(8.2)	(10.6)	(20.0)	
Pacific	3,237	4,250	31.3	294	506	38.0	31.9
	(10.2)	(10.9)	(6.9)	(0.9)	(1.0)	(11.1)	
Washington	432	575	33.3	41	56	35.7	33.1
	(10.4)	(11.8)	(13.4)	(10.4)	(11.8)	(20.0)	
Oregon	303	391	29.0	28	39	36.5	34.5
	(11.5)	(13.8)	(20.0)	(11.5)	(13.8)	(27.3)	
California	2,414	3,136	29.9	218	300	37.2	31.5
	(10.2)	(10.5)	(2.9)	(10.2)	(10.5)	(11.1)	
Alaska	12	22	93.7	1	1	102.1	29.4
	(2.9)	(4.1)	(41.4)	(2.9)	(4.1)	(0.0)	
Hawaii	76	125	64.2	6	10	87.0	32.6
	(7.9)	(11.3)	(43.0)	(7.9)	(11.3)	(50.0)	

SOURCE: 1980 and 1990: Bureau of the Census, (1992b); median age, 1990: Bureau of the Census (1992a).

10

Research on the Demography of Aging in Developing Countries

Linda G. Martin and Kevin Kinsella

INTRODUCTION

The study of the demography of aging in developing countries is a relatively new endeavor, which expanded enormously in the 1980s. Anthropologists have been examining social and economic aspects of aging in developing countries for at least 50 years; most notable is the classic work by Simmons (1945), which presented evidence that high status of the elderly was not necessarily guaranteed in primitive societies. In the 1970s, Cowgill published his modernization theory, which posited that the status of the elderly declines in the process of socioeconomic development (Cowgill and Holmes, 1972; Cowgill, 1974). This theory has since generated considerable response—both positive and negative—in sociology and gerontology.

It was only in the 1980s that demographers began to focus on aging in developing countries (see, for example, Treas and Logue, 1986; Kinsella, 1988; Martin, 1988), and economists have been even slower to take up the issue. Demographers were motivated by population projections indicating that declining fertility and mortality, particularly in Asia and Latin America, were resulting in population aging. Their interest was also motivated by the

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concerns of policy makers in these countries, which arose from those projections and from the focus on aging at the 1982 United Nations World Assembly on Aging. Interest in comparative research involving developing countries has been based on the belief that it can provide insight into the influences of culture and ethnicity, the particular effects of aging in low-income environments, the changing roles of families, and the consequences of new policies and programs.

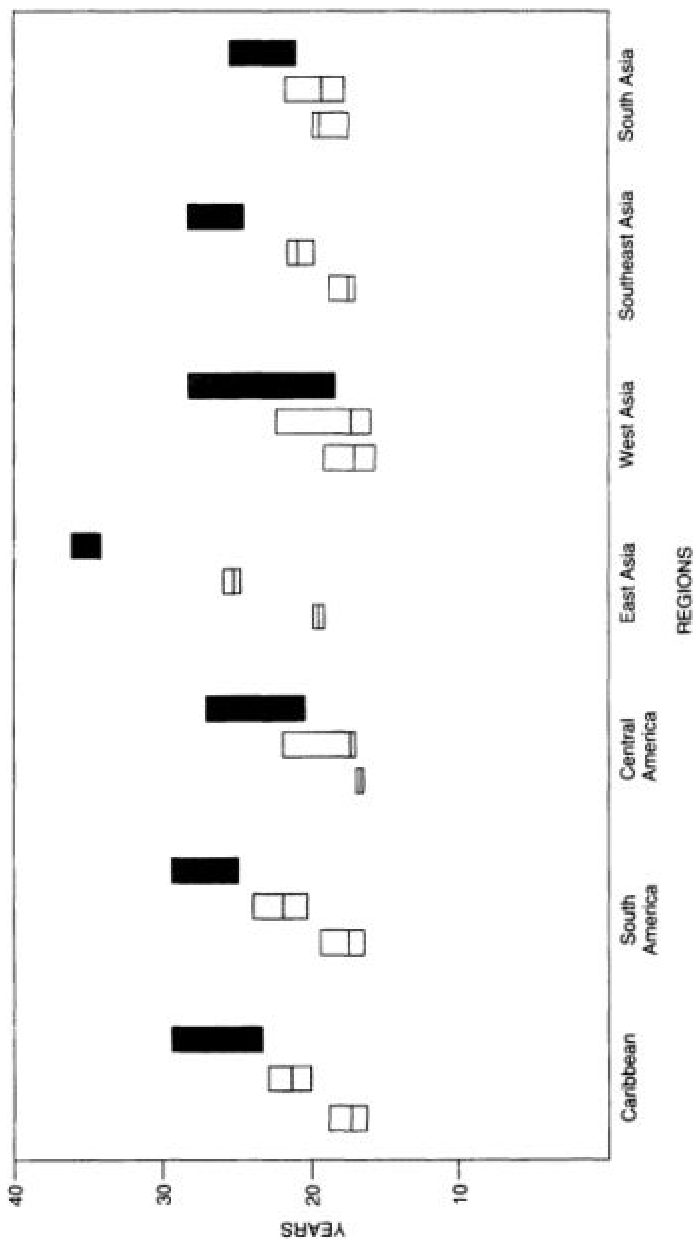
In this chapter, we review research on the demography of aging in developing countries in several substantive areas, namely, basic demography, mortality and health, family demography, population distribution and migration, and economic activity and well-being. We conclude with a summary of data collection and research challenges and provide an appendix that highlights the current availability of different types of data—survey, census, vital statistic, and ethnographic—for research on these topics.

BASIC DEMOGRAPHY

Much of the early work of demographers on aging in developing countries focused on raising awareness of aging as a policy and research issue. A decade ago, most conference papers and journal articles emphasized projections of population aging and were basically alarmist in their discussions of the implications. No doubt, such consciousness raising was needed. More sophisticated projection work was also done, for example, Yu and Horiuchi's (1987) analysis of the relative contribution of fertility and mortality change, as well as initial age structure, to population aging in more and less developed countries, and Zeng's (1986, 1988) projections of family structure in China.

The essence of the projections is that populations are indeed aging in most of the developing world except parts of Africa; United Nations (1991) estimates for 1990 indicate that 56 percent of the world's 65 and over population already lives in less developed countries. Moreover, some of the populations of East and Southeast Asia are aging at substantially more rapid rates than was the case historically in the West (Chen and Jones, 1989). Figure 10-1 presents the changes over time in median ages for countries that in 1989 had per capita incomes of less than $5,000. The data are taken from the United Nation's (1991) estimates for 1970-1975 and medium-variant projections for 1990-1995 and 2010-2015. The countries are divided into 12 subregions of Latin America, Asia, and Africa. The line in the middle of each box indicates the median of the median ages for the countries in that subregion and period. The height of the box shows the interquartile range (25 to 75 percent) within which the median ages of the middle half of the countries in each subregion fall.

Latin America and Asia show substantial increases in median age over


YEARS
40
30
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South America
Central America
East Asia
West Asia
Southeast Asia
South Asia
REGIONS

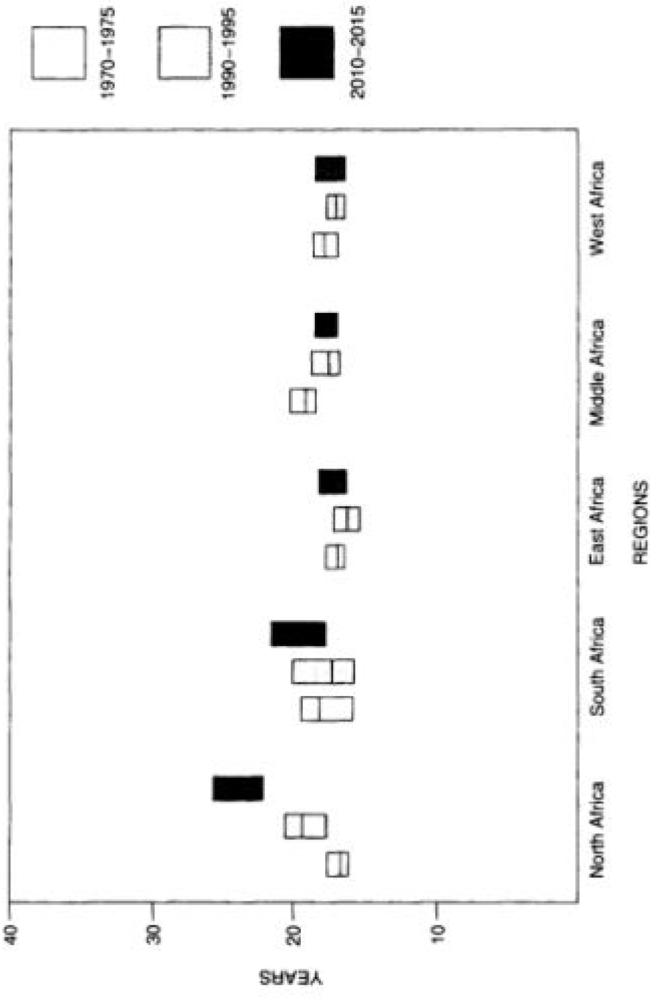

Figure 10-1
Median and interquartile ranges of median age, 1970-1975, 1990-1995, 2010-2015, for each subregion for countries with per capita income under $5,000 in 1989. SOURCES: Median ages are from the United Nations' (1991) estimates for 1970-1975 and medium-variant projections for 1990-1995 and 2010-2015. Per capita income in 1989 is from the Population Reference Bureau's 1991 data sheet.

time, but in East, Middle, and West Africa, there is very little change, with the median of the median ages decreasing between 1970 and 1990, and only barely increasing from 1990 to 2010. Of course, the changes over the latter period are based on the assumptions that the total fertility rates in these three subregions will be on average 4.32, 4.99, and 4.53, respectively. Higher or lower fertility would change the results shown here, but the overall impression of little change in median ages in African populations in comparison to the rest of the developing world would remain. Nevertheless, it is important to remember that such national median ages may mask considerable diversity within countries, with urban and female populations typically being older than rural and male populations. Moreover, static or slow-rising median ages convey nothing about the absolute numerical growth of various age groups.

Besides projections of proportions elderly and of median ages, demographers have also used projections of dependency ratios (e.g., the ratio of the under-15 plus 65-and-over population to the population in the middle) to summarize the changes in population age distributions likely to take place.[1] The good news is that increases in elderly "dependents" will likely be more than offset by decreases in young "dependents," at least in the short run, for developing countries, but the bad news in parts of Asia is that when the large birth cohorts of the 1960s and 1970s reach old age, overall dependency ratios are likely to increase.

Of course, not all persons under 15, over 65, or even over 80 are dependent in an economic or care-requiring sense. The total costs and contributions, both public and private, of the young and the old have not been adequately determined in the United States (Siegel and Taeuber, 1986), let alone in the developing world. Hence, dependency ratios are useful more as illustrative devices than as analytic tools, and could certainly be refined through incorporation of factors such as age-specific labor force participation and availability of economic resources.

Demographers have played an important role in compiling and summarizing the basic characteristics of elderly populations (e.g., marital status, urban/rural residence, labor force participation). An initial effort to produce individual country reports on elderly populations began in 1984 under the auspices of the Committee for International Cooperation in National Research in Demography (CICRED) and resulted in monographs from several developing as well as developed countries. Many of the data generated

[1] Crude generational support ratios, which relate the size of successive generations to one another (e.g., persons aged 80 and over versus persons (or women) aged 50-64) also have been used, primarily in developed countries, as indicators of potential care burdens for nonelderly adult cohorts.

by the CICRED project became the foundation for the International Data Base on Aging of the Center for International Research at the Bureau of the Census. An expansion of this initial data set formed the basis for the publication *Aging in the Third World* (Kinsella, 1988) and a subsequent wall chart of summary indicators for 100 countries (Bureau of the Census, 1991). The challenge for the future is to obtain comparable data sets over time that make possible the measurement of changes in demographic and socioeconomic characteristics and provide insight into how the elderly of tomorrow may differ from those of today.

MORTALITY AND HEALTH

In developing countries, the focus of most nationally and internationally sponsored health programs has been on infectious and parasitic diseases and child survival, and in fact, many developing countries have succeeded in reducing the incidence of tropical diseases and of infant and child mortality in particular (Hill and Pebley, 1989). However, as children survive and age, they are increasingly exposed to risks associated with chronic diseases and accidents. And as fertility decline induces population aging, national mortality and health profiles begin to reflect the growing importance of chronic and degenerative ailments associated with greater numbers of older individuals (Frenk et al., 1989). In the last few years, there has been considerable attention paid to the emerging health issues in developing countries (Caldwell et al., 1990; Jamison and Mosley, 1991; Feachem et al., 1992). In this section, we first review research on mortality in the adult years in developing countries, then discuss research on morbidity and disability, and studies of health care utilization and costs.

Mortality

Demographers have long been interested in measuring adult mortality in developing countries, but limited or defective data have constrained analysis. Timæus (1991b) points out that also complicating the study of adult mortality are the facts that adult deaths are *relatively* rare events, that there is not necessarily an appropriate informant about an adult death, and that age misreporting is common. He goes on to review the array of direct and indirect methods that demographers have used to try to estimate adult mortality. Analyzing patterns of causes of deaths and their changes over time is even more difficult. As discussed in the appendix to this chapter, reliable information through vital statistics on cause of death is available for only, at most, half of the deaths in developing countries (Bulatao, 1993), and age exaggeration is a problem, especially in Latin America (Dechter and Preston, 1991).

Nevertheless, there is growing evidence that an epidemiological transition is under way in many developing as well as developed countries (see for example, Murray et al., 1992b). Adult survival has improved, death rates for infectious and parasitic diseases have declined, and chronic and degenerative diseases are becoming relatively more important.

On a regional basis, the epidemiological transition appears most advanced in Latin America and the Caribbean (Bulatao, 1993). Analysis from the Pan American Health Organization (1990) indicates that cardiovascular diseases are the principal cause of death in the populations of 27 of the 37 countries of the Americas for which recent mortality data are available. In 6 of the remaining 10 countries, cancer or cerebrovascular disease is the leading killer. Bulatao (1993) has estimated that in Latin America and the Caribbean, the ratio of deaths from circulatory system diseases to deaths from infectious and parasitic diseases increased from 0.68 to 1.09 between 1970 and 1985.

Frenk et al. (1989) have demonstrated that in some Latin American countries, the stages of epidemiological transition overlap, such that populations suffer simultaneously from high incidences of infectious and parasitic as well as chronic and degenerative diseases. In some cases, pretransition diseases that were once essentially controlled (e.g., malaria, dengue fever, cholera) have reemerged as major contributors to morbidity burdens (Brandling-Bennett, 1991; Oakes et al., 1991).

The diversity of experience in Asia defies regional generalization (Ruzicka and Kane, 1991). Clearly, mortality decline has been greater in East and Southeast Asia than in South and West Asia. In Singapore, life expectancy at birth rose 30 years in barely one generation, from 40 years in 1948 to 70 years in 1979 (Bureau of the Census, various years). During the same period, deaths due to infectious diseases declined from 40 to 12 percent of all deaths, while the share of cardiovascular deaths rose from 5 to 32 percent. Data from selected areas of China in 1986 indicate that circulatory diseases are the primary killers, accounting for 47 percent of all deaths, and cancer accounts for 17 percent of deaths (World Bank, 1992). Similar patterns have been reported for Turkey and Sri Lanka, but to date, comparable indicators for the majority of South and West Asia are not available.

Improvements in adult survival in African nations, especially in the sub-Saharan region, lag behind those of all other major regions of the world (Feachem and Jamison, 1991). Nationwide health and mortality data typically are unavailable, but subnational and community-level data indicate that infectious and parasitic diseases remain the most important causes of mortality among adults in Africa (Timæus, 1991a). There is evidence, however, that cardiovascular disease, respiratory tuberculosis, and accidents and violence affect adults disproportionately.

Several research efforts have moved beyond description of mortality patterns and their changes at the national level. These have included the following:

1. Efforts to compare mortality in urban and rural areas. Bumgarner and colleagues (World Bank, 1992) found considerable differences in mortality from infectious disease in urban and rural China, with rates for rural men being almost twice those for urban men, and the difference being fourfold for rural and urban women. Differences in mortality rates from chronic diseases are much smaller, but rural dwellers experience slightly higher rates than do urban dwellers. Altogether in 1986, circulatory diseases and cancer accounted for 67 percent of reported deaths in urban areas and 64 percent in rural areas.
2. Decomposition of mortality differences in life expectancy between countries and years by gender and causes of death (Pollard, 1982; Arriaga, 1984, 1989). For example, Adlakha and Arriaga (1992) compared patterns of mortality in Guatemala and Costa Rica to identify areas of dissimilarity and highlight realistic targets for scarce health resources. They found that of 25 causes examined, just four—intestinal infection, pneumonia, conditions originating in the perinatal period, and nutritional deficiency—were generally responsible for the large mortality differential for both sexes between the two countries (14-year longer life expectancy at birth in Costa Rica in the mid-1980s). In addition, violence (including suicide and homicide) is an important contributor to lower male life expectancy in Guatemala. These five causes, if reduced to the levels in Costa Rica, would add 10 to 11 years to overall Guatemalan life expectancy, in contrast to only 3 to 4 years added by the other 20 causes.
3. Projections of mortality by cause and broad age groups. Bulatao and Stephens (in press) based their worldwide projections on a model of the relationship between mortality level and cause of death structure in populations with good data. Dowd and Manton (1990) projected death rates from chronic diseases in Cuba, Ghana, Mauritius, Sri Lanka, Tanzania, and Thailand based on information on risk factors in those countries and the estimated relation between risk factors and mortality in more developed countries. Complicating such projections is the extent to which the consequences of changes in behavior (e.g., smoking) affect mortality over time. For example, smoking is thought to have increased rapidly in recent years in China; by 1984, 61 percent of adult Chinese men smoked (*British Medical Journal,* 1991).

Disability and Morbidity

Successes in lengthening life expectancy have raised new questions about whether added years of life mean a healthier life or an increased burden of chronic illness. Liang and Whitelaw (1987) have suggested that physical health can be measured in three ways: (1) medically, through detection of disease or impairment; (2) functionally, through tests of the ability to perform activities of daily living; and (3) subjectively, through self-assessment of health or functional ability. [2] To date, data on the health status of adults and, in particular, the elderly in developing countries are largely of the last two types and have been collected through surveys. Census data on particular types of disability (e.g., blindness) are also available for some countries.

Surveys generally do not involve physical examinations because of the costs involved, although there are some notable exceptions: for example, the 1976-1977 Indonesian Health Survey conducted by local physician interviewers; physical examination surveys in Colombia, Egypt, and Uruguay (see Murray et al., 1992a, for some of the results); the World Health Organization (WHO) Noncommunicable Disease prevention program, which sponsored cross-sectional surveys focused on cardiovascular disease risk factors such as cholesterol and blood pressure in six developing countries (see Dowd and Manton, 1990); and risk factor surveys in Brazilian cities (see Briscoe, 1990). Perhaps surprisingly, the last indicate that risk factors for chronic diseases are higher among people of lower socioeconomic status than among those of higher status.

Most importantly for understanding and modeling health processes, longitudinal data on risk factors and functional status transition rates are virtually nonexistent. The World Health Organization is currently designing three cross-national survey programs that will begin to fill this gap. These surveys (see appendix table) will incorporate clinical as well as self-perceived measures, on a longitudinal basis, and will contrast urban and rural locales in both developed and developing countries. Two of these survey programs are focused on specific causes of disability, osteoporosis and age-associated dementias; the third is a broader investigation of the determinants of healthy aging.

The systematic study of disability in developing countries is still in its infancy. Due largely to efforts spearheaded by the United Nations Statistical Office (UNDIESA, 1990), there is greater awareness of the need to collect and tabulate data on impairments, disabilities, and handicaps. The creation of a Disability Statistics Data Base (DISTAT) has been an important first step in highlighting international differences in the definition and description of disability, as well as enabling provisional international comparisons. At present there is enormous variation in international definitions

[2] Due to space limitations (and admitted unfamiliarity with the literature), we do not review measurement of mental health.

and rates of disablement. Among countries included in DISTAT, crude disability rates for the total population range from less than 0.5 percent in several developing countries (Peru, Egypt, Pakistan, Sri Lanka) to nearly 21 percent in Austria. In recognition of the wide conceptual disparities, an international network has been established to assist countries in defining and developing information on disablement, with the goal of harmonizing concepts of impairment, disability, and handicap (Chamie, 1990).

Incidence of disability also differs by age, sex, and other social characteristics. Despite definitional and measurement differences between countries, several patterns emerge. Regardless of the levels of crude disability, rates tend to rise with age and increases are especially notable in later adulthood. Males usually have higher rates than females at most ages. And the profile of disability changes with age as well, because certain disabilities are directly related to age. Muteness, for example, reaches a peak in the later teen years, then is relatively constant at older ages. Deafness, on the other hand, shows a distinct rise with age among adults, especially after age 50. Vision disability is also related to age.

The most common survey measures of disability of the elderly in developed countries are activities of daily living (ADLs)—the basic tasks of everyday life such as eating, dressing, toileting, bathing, and ambulation (Katz et al., 1983)—and instrumental activities of daily living (IADLs) such as shopping and using transportation. The ability to perform such activities (especially ADLs) has been found to be a significant predictor of outcomes such as mortality, use of hospital and physician services, insurance coverage, admission to nursing homes, and living arrangements (Wiener et al., 1990). Several surveys of the elderly in developing countries (e.g., those listed in the appendix table that have been conducted by the Association of Southeast Asian Nations (ASEAN), WHO Regional Offices, the United Nations University, and the University of Michigan and the Taiwan Provincial Institute of Family Planning) have asked respondents to assess their abilities to perform ADL and/or IADL. Andrews et al. (1986) have found responses to these questions to be quite reliable in retests and consistent with interviewers' assessments. Unfortunately, as in more developed countries, these questions do not necessarily discriminate well in community-based populations. For example, Andrews et al. (1986) found that the proportions of the 60-and-over population able to perform all of the ADLs were 71 percent in Korea, 90 percent in Malaysia, and 91 percent in the Philippines. Moreover, there is some question about the appropriateness in a developing country setting of some of the instruments developed in industrialized countries. For example, Ikels (1991) in her study of 200 people ages 70 and over in Canton, China, chose not to use any standard instrument and relied instead on her own assessment of the functionality of the individuals through in-depth, informal interviews. Applying such a proce dure on a larger scale, however, would not likely be feasible. Studies of how the elderly and other age groups spend their time in specific developing country settings could help inform the development of more appropriate instruments for measuring activities of daily living.

Numbers of disabled persons are almost certain to increase as a correlate of sheer population growth and population aging (see, for example, Dowd and Manton, 1992, on Indonesia). But an important question for both developed and developing countries is whether or not rates of disability are likely to increase as economies modernize and populations age (Mosley and Cowley, 1991). Census data for Turkey show declining rates of disability between 1975 and 1985 for children, but increases for men and women in almost all adult age groups. This trend also has been observed in Bangladesh and Egypt.

Data on disability have been used to estimate years of healthy life expectancy in developing countries.[3] For example, although female life expectancy at birth and at age 65 is usually greater than that of males, analysis based on data from the WHO Regional Office surveys of the elderly in Asia indicate that the percentage of lifetime expected to be spent in a healthy state is lower for women than for men (Lamb and Andrews, 1991; Myers, 1993). A multivariate procedure called graded order of membership has also been applied to disability data from developing countries to identify distinctive patterns of disability and the subgroups of the population that manifest them (Manton et al., 1986, 1987).

Self-assessments of health are common components of population-based surveys, including various surveys of the elderly in developing countries. Of course, such assessments reflect perceptions of illness, as well as underlying disease patterns, both of which may change in the course of socioeconomic development. Riley (1990) noted for Britain, Japan, and the United States that the prevalence of sickness has increased for all age groups, even as mortality has declined; he reviewed possible explanations for this anomaly, including changing perceptions of illness.

There is, of course, tremendous variability in how questions about health are asked (e.g., differences in reference periods—week, month, or ever; whether general questions are followed with probes about specific disease; and whether information on duration and intensity of illness is obtained). Ability to respond about specific diseases or symptoms may be confounded with cognitive ability and with receipt of medical care (Liang and Whitelaw,

[3] One effort to facilitate and promote analyses of health expectancy was initiated in 1989. The international network REVES (the French acronym for the International Network on Health Expectancy and the Disability Process) brings together researchers from both developed and developing countries concerned with measuring changes in health status.

1987). Even so, in the United States, self-perceptions of health have been found to be excellent predictors of mortality (Massey and Shapiro, 1982; Idler and Kasl, 1991). Research on this topic for developing countries has yet to be done.

Comparisons of self-assessments of general health with other self-assessments of specific conditions and with somewhat more objective measures of health sometimes yield contradictory patterns. For example, data from the WHO indicate that elderly Filipinos reported the most positive assessments of their health among the three Asian populations in the study, but they also had the greatest incidence of illness and injury, as well as limitations of hearing and vision (Andrews et al., 1986). Murray et al. (1992a) reported that the ratio of self-perceived to observed morbidity varies by disease and across communities.

Murray et al. (1992a) also reviewed patterns of self-reported morbidity by age, gender, and income for Côte d'Ivoire, Ghana, Pakistan, Peru, and Thailand. They found that morbidity generally increases with age, is greater for men than women, and is more common among the rich than the poor. However, the relation with age is not perfectly monotonic in all of the countries. Similarly, Knodel et al. (1992a) found in Thailand, using a different data source, that reported illness did not consistently increase with age. Strauss et al. (1992) analyzed multivariately the determinants of self-reported adult health in Jamaica and found that health problems increase with age, but that women report more health problems at earlier ages than do men. They also found that less education is associated with poorer health, but that long-run household income has no effect. This type of analysis is needed for other developing countries, and researchers at RAND are investigating the measurement of health and its determinants as part of the Indonesian Family Life Survey.

Health Care Utilization and Costs

Besides investigating mortality, morbidity, and disability, demographers with an interest in aging in developing countries are beginning to study patterns of health care utilization and costs. For example, Caldwell et al. (1990) have proposed a broadening of the concept of the epidemiological transition to that of a health transition, which includes social, economic, and behavioral changes, as well as changes in morbidity and mortality. New medical technologies are emerging, and countries are organizing or reorganizing their health care delivery systems, but health care-seeking behavior is conditioned not only by the available services but also by economic factors, family decision-making dynamics, and household coping mechanisms.

Several studies in developing countries suggest that the use of health and hospital resources does not necessarily increase monotonically with age. The WHO Regional Office for the Western Pacific surveys of the 60-and-over population in four countries found no strong age pattern in those who had seen a health professional (physician, nurse, or pharmacist) in the month prior to the survey (Andrews et al., 1986). Using data on all ages, Knodel et al. (1992a) reported a U-shaped pattern of use of health sources in Thailand, but for those ages 60 and over there was no clear pattern by age. Murray et al. (1992a) showed that among those reporting themselves as ill in Côte d'Ivoire, those over age 60 were least likely of all the age groups to seek consultation.

There is generally a stronger relation between age and hospitalization (Knodel et al., 1992a, on Thailand; Murray et al., 1992a, on Côte d'Ivoire, Ghana, and Peru; Barnum and Kutzin, in press, on Jamaica and Korea), but once again, within the subgroup of elderly, the relation is not necessarily monotonic. Knodel et al. (1992a) suggested that limited mobility and greater mortality in this age group may account for the lack of association; however, they also noted that once hospitalized, the elderly tend to have longer stays. They combined these cross-sectional statistics on utilization of services with projections of changes in age structure and concluded that barring major changes in utilization patterns, the elderly in the future are likely to make disproportionate use of hospital services and, accordingly, demand for such services will increase dramatically as a result of population aging. In a similar exercise, Dowd and Manton (1992) projected the increased demand for surgery, protheses, and rehabilitation services in Indonesia as a result of population aging.

There are also new inquiries into the implications of population aging for the cost of health services.[4] Murray et al. (1992a:179) noted that "many developing countries spend 50 percent or more of their government budget on hospitals, where adults consume up to two-thirds of the resources." However, data on health care costs by age present a mixed picture. Besides severity of illness, age could also reflect ability or willingness to pay for services. For example in Côte d'Ivoire in 1985, per capita medical expenditures on persons ages 60 and over and in ill health were lower than those for the 40-59 group and about the same as those for the 15-39 group. The 60-and-over group accounted for 15 percent of days spent in illness, but only 11 percent of private medical expenditures. In contrast, older Koreans in 1986 accounted for 14 percent of hospital admissions and 18 percent of hospital costs (Murray et al., 1992a).

Additional efforts are currently being made to utilize the limited data

[4] Due to space limitations, we do not discuss types of payment for health care, such as public or private insurance, which is not widely available in most developing countries.

available on health care costs in three studies of costs by age and gender being funded by the Office of Health of the U.S. Agency for International Development. The study in Jamaica uses data from the Living Standards Measurement Survey, the study in Lesotho is based on administrative records from hospitals, and the study in Costa Rica is relying on social security records.

A major World Bank study (Jamison and Mosley, 1991) assesses the cost-effectiveness of alternative disease intervention strategies by estimating the years of healthy life gained. Although child survival interventions are generally cost-effective, some adult health interventions also are. Among them are antismoking campaigns plus tobacco taxes and some interventions related to tuberculosis. Complicating the trade-off between investments in child and adult health is the evidence that health in childhood plays a major role in adult mortality (Elo and Preston, 1992). Moreover, although prevention of chronic disease and injury is an appealing and apparently logical focus for developing country health schemes, Frenk et al. (1991) have argued that implementation of preventive measures is often hampered by at least three factors: (1) skepticism about the efficacy of educational programs; (2) the lack of control that health ministries have over many of the potential interventions (e.g., alcohol and tobacco taxes, use of seat belts); and (3) political realities that require demonstrable short-term benefits at the possible expense of long-term salubrious effects of disease prevention (Frenk et al., 1991).

FAMILY DEMOGRAPHY

As in the developed world, most caregiving to those elderly in developing countries who need assistance is done by families. However, in neither is caregiving devoid of stress, although there has been a tendency for both Western and developing country writers to idealize the role of the family in developing countries (Nydegger, 1983). Also, as in the West, older people in developing countries provide assistance to their younger family members, although there is some tendency in the literature to view the elderly as completely dependent.

Critical to understanding the family relations of the elderly is obtaining a complete picture of the kin option set, that is, obtaining information about all the family members whether they live together or not. An ideal data set might include not only numbers and relationships, but data on age, marital status, number of children, and labor force participation of each person. Most data sets do not provide so much, but a considerable amount of research has been done on the family demography of aging, especially in Asia (see, e.g., the special issue of *Asia-Pacific Population Journal* (Volume 7(3), 1992), that focuses on social and economic support systems of the elderly in Asia). This emphasis has no doubt been partly driven by the interests of Western scholars, but it has also been a function of concern on the part of Asian policy makers about just what can be expected from family members in the future. Ideals of filial piety and caring for the elderly are strong, but now that there are more opportunities to put them into practice, as well as dramatic socioeconomic changes, questions about actual behavior are arising.

Demographers have been especially helpful in spelling out the implications of declines in fertility and mortality for the number of children that older people will have in the future, as well as their prospects for remaining married. Hermalin and Christianson (1992) used census data to project the number of children ever born among older women in Taiwan from 1985 to 2020. Although fertility has declined rapidly in Taiwan in recent decades, the effect on the numbers of children that older women have will be felt only with a lag. For example, in 1980, women aged 60 and over had given birth during their reproductive periods to an average of 5.4 children. By 2000 the number will still be relatively large, 4.73, and only in the twenty-first century does it begin to fall dramatically, reaching 2.89 by 2020. Zeng (1986, 1988) used simulations to model availability of kin in China, where there has been considerable concern about the implications of the one-child policy, and Tu et al. (1993) have done microsimulations for Taiwan. Data from the 1989 Taiwan Survey of Health and Living Status of the Elderly provide the most detailed description of kin availability of the elderly for any developing country (Hermalin et al., 1992b). Some scholars have argued that it is not necessarily the number of children that matters for family support as long as there is at least one (although, as discussed below, research on the determinants of living arrangements in Asia provides some evidence that *number* of children does indeed matter, and the special issue on childlessness of the *Journal of Cross-Cultural Gerontology* (Volume 2(1), 1987) provides examples of coping mechanisms for the childless elderly). Myers (1992) presented estimates for a number of countries around the world of the proportion of women ages 45-49 in the late 1970s who were childless. (He noted that both voluntary and involuntary factors influence childlessness, but was unable to specify reasons for the relative percentages of the various countries.) The percentages were generally much less than 10, although Egypt, Bangladesh, Brazil, Ecuador, Peru, and Uruguay were exceptions with larger proportions. Future trends in childlessness will depend on the extent to which current childlessness reflects volition or not. In the latter case, with improvements in health, childlessness might be expected to decline, but delays in marriage and preferences for smaller families augur an increase.

Of course, family assistance is not necessarily all intergenerational, and Lee and Palloni (1992) used the case of Korean women to model the impli cations of mortality decline for widowhood. Their cohort life-table analysis indicates a reduction in the proportion of widows at each age, delay in the onset of widowhood, and decrease in its duration, results that are not as apparent as one might think. However, as they note, "it remains questionable how much of the improved survival of their husbands will be translated into elderly women's well-being" (Lee and Palloni, 1992:86).

Perhaps not surprisingly, given differences in age at marriage and in mortality, men are more likely to depend on their spouses should they become incapacitated than are women. The ASEAN surveys found that 34 percent of males in comparison to 8 percent of females received care from their spouses, whereas the proportions receiving care from children were 48 and 72 percent, respectively (Chen and Jones, 1989:Table 6.9). The importance of spouses as well as children in caregiving is also clear in Taiwan, where a third of the elderly who receive assistance with activities of daily living identify their spouses as the most important providers, as opposed to 55 percent identifying children or children-in-law (Hermalin et al., 1992a).

Although assistance can be given across household boundaries, living arrangements of the elderly have been the focus of much of the initial analysis of their family relations. Table 10-1 shows the proportion of older people (either 60 and over or 65 and over) in various developing countries who were living alone in the late 1970s and the 1980s. In Asia, less than 10 percent of the elderly live alone, but in Latin America and especially the Caribbean, the percentages are much higher. Kinsella (in press) noted that, as opposed to Asia where older women are more likely to live alone than men, in the Caribbean the pattern is the opposite, in part due to patterns of migration and union formation unique to parts of the region.

Until recently at least, approximately three-quarters of elderly Asians lived with one or more of their adult children (Martin, 1988). However, evidence from Taiwan and Korea indicates that the proportion is declining. For Taiwan, Weinstein et al. (1989) noted a decline in coresidence from 81 to 69 percent over the 1973-1985 period, although part of this change may be due to the increasing prevalence among the elderly population of mainland Chinese who migrated to Taiwan shortly after World War II and do not have extensive family networks. Using Korean census data, DeVos and Lee (1988) showed that the proportion of the 60-and-over population living with their married adult children declined from 71 to 64 percent in the 1970s. The decline occurred for all age groups, for those with and without spouses, and among both men and women, although the decline was smallest for the oldest-old and for those who were widowed, indicating perhaps that coresidence was becoming less customary and more related to the special needs of the elderly.

The determinants of the living arrangements of the elderly in developing countries is probably the topic that has been subject to the most multi variate analysis, with the focus primarily on Asia, but also some work on Latin America. DeVos and Lee (1988) analyzed Korean census data for 1970 and 1980; Martin (1989b) used WHO data for Fiji, Korea, Malaysia, and the Philippines; Casterline et al. (1991) relied on the ASEAN data for the Philippines, Singapore, and Thailand, plus the 1989 Taiwan data; Chan and DaVanzo (1991) analyzed the 1988-1989 Second Malaysian Family Life Survey data; and DeVos (1990) used mid-1970s World Fertility Survey

TABLE 10-1 Household Population Aged 65 Years and Over (unless noted) Living Alone: Latest Available Data (percent)

Asia		Central/South America	
China (People's Republic), 1987 (60+)	3.4	Argentina, 1980	12.0
Indonesia, 1986 (60+)	8.0	Brazil, 1980	9.8
Korea, Republic, 1984 (60+)	2.2	Chile, 1984-1985 (60+)	7.0
Malaysia, 1986 (60+)	6.4	Colombia, 1976 (60+)	5.0
Philippines, 1984 (60+)	3.0	Costa Rica, 1985/1986	6.9
Singapore, 1986 (60+)	2.3	Dominican Republic, 1975 (60+)	9.0
Sri Lanka, 1987 (60+)	7.6	French Guiana, 1982	40.0
Taiwan, 1989	8.9	Mexico, 1981 (60+)	6.4
Thailand, 1986	6.4	Panama, 1976 (60+)	11.0
		Peru, 1977 (60+)	8.0
		Uruguay, 1985	16.2
Caribbean		Other	
Barbados, 1982	27.1	Côte d' Ivoire, 1986	2.8
British Virgin Islands, 1980	20.4	Fiji, 1984 (60+)	2.0
Cuba, 1981	10.0	Réunion, 1982	23.3
Dominica, 1980	18.6		
Grenada, 1981	21.0		
Guadeloupe, 1982	32.4		
Jamaica, 1984	23.0		
Martinique, 1982	30.6		
Montserrat, 1980	25.2		
St. Lucia, 1980	19.7		
St. Vincent, 1980	16.5		
Trinidad/Tobago, 1985 (60+)	13.6		
Turks and Caicos, 1980	17.9		

NOTE: Mexico refers to urban and suburban elderly in four states. Costa Rica refers to two cantons only. Jamaica refers to a single urban community of Kingston. Indonesia refers to the island of Java. Malaysia refers to three Peninsular states.
SOURCE: Compiled by the Bureau of the Census from primary census and survey volumes, international compendiums, and published research.

data for Colombia, Costa Rica, the Dominican Republic, Mexico, Panama, and Peru.

All of the studies highlighted the importance of the availability of kin for the living arrangements of the elderly. In all the studies, being widowed raised the probability of living with a child. Similarly, for the Asian studies that focused on the issue (Martin, Casterline et al.), having a larger number of children was associated with a greater probability that the older person was living with at least one of them.

DeVos and Lee found that the older the person, the greater was the likelihood of living with a child, but Martin, who included a measure of ability to perform activities of daily living, which had no effect, found that for three of the countries, *less* coresidence was associated with older age. Casterline et al. shed light on this puzzling finding; they found that for Taiwan and Thailand, but not for the Philippines, the negative effect of age on coresidence was eliminated once they controlled for the age of the youngest child. Thus, some of the coresidence was likely associated with the needs of the children, rather than the needs of the elderly. One would expect the former to decrease and the latter to increase with the age of the older person.

In addition to studying the influence of kin availability, the research has also focused on the effects of "modernization" (i.e., whether coresidence is less among the more educated, urban elderly with greater economic resources). Casterline et al. did indeed find less coresidence among the more educated, but they found more coresidence in the largest cities than in smaller cities and rural areas.[5] The latter result raised the possibility that coresidence in big cities might be motivated by high housing costs and the need to double up. Chan and DaVanzo included a measure of community-level housing costs in their analysis and found that it was positively associated with coresidence, although they also obtained the puzzling result that coresidence was equally likely in rural areas and big cities, but less likely in small cities, even when housing costs were included in the model. DeVos found that among Dominican Republic males, rural residence was associated with a lower incidence of living in an extended family, perhaps reflecting the out-migration of young people, but she found that among Panamanians of both sexes, there was more coresidence in small cities in comparison to large cities and rural areas.

Chan and DaVanzo also were able to include in their model an indicator of income, which as discussed later is very difficult to measure in surveys, and found that those with greater economic resources were more likely to

[5] DeVos and Lee (1988) also found greater coresidence in Seoul, and Martin (1989b) found greater coresidence in urban areas of the Philippines.

be living apart from their children. Thus, it may be that at least some of the elderly of Asia prefer privacy, and once they have the resources to achieve their preferences, they do so. Ramos (1992:230) noted that such may also be the case in Brazil and urged that the advantages of multigenerational coresidence not be overemphasized: "... contrary to some prevailing beliefs, it is the elderly living in multigenerational households who require formal support because of their poverty." Similarly, Knodel et al. (1992b) concluded on the basis of their focus group work in Thailand that despite the normative basis for coresidence, there are costs as well as benefits, and they speculated that some elderly may in the future purchase greater privacy as their economic well-being increases.

Finally on the topic of living arrangements, both the Martin and the Chan and DaVanzo analyses highlighted the importance of culture as indicated by ethnic differences in living arrangements. In Malaysia, the Malays are less likely to live with their children than are the Chinese or Indians, whereas in Fiji, ethnic Fijians are less likely to coreside than Indians.

Despite the relative plenitude of research on this topic, there remain many unresolved issues (e.g., the relation of health to living arrangements; the influence of urban versus rural residence, including the role of housing costs and migration of children; and the extent to which privacy is preferred). Also, there is a need for more complex models that take into consideration more characteristics of the younger generation.[6] And, finally, research on transitions in and out of institutions is nonexistent.

Of course, support can be given across household boundaries, so living arrangements are not the only topic of interest in studying family relations in an aging population. As mentioned earlier, both spouses and children provide assistance with activities of daily living to elderly Asians. Moreover, Knodel et al. (1991) found that in Thailand the life course stage of children is associated with the type of assistance that they provide (e.g., single non-coresident children living some distance away from their parents are more likely to provide money, whereas married non-coresident children in the same community are more likely to provide food and clothing). For Taiwan, Hermalin et al. (1992a) found that sons are the most important providers of financial assistance, whereas both sons and daughters are important sources of material goods, and daughters-in-law and spouses provide personal assistance. As in the developed countries, researchers are just

[6] Such analysis will be possible using the 1989 data from Taiwan, and a dissertation on this topic is currently being written by Mary Beth Ofstedal at the University of Michigan. Preliminary analysis reported in Ofstedal and Chi (1992) indicates that the elderly are most likely to live with one child of any marital status or two unmarried children. Less likely outcomes are living with one married and one unmarried child, with two married sons, or with any duet of children including a married daughter.

beginning to refine their data collection and analytical techniques for the study of such exchanges.

As mentioned earlier and highlighted in the initially curious findings about age and coresidence, the intergenerational flow of resources is not all one way. Many elderly people may indeed continue to provide financial and material support to their children well into their adult years. They may also play important roles around the house that help facilitate the productivity of the younger generation. For example, Andrews et al. (1986) noted that in the four countries in Asia and the Pacific that they studied, more than half of the respondents indicated that they helped take care of grandchildren. But provision of such time-intensive services is possible only when the generations of a family live close to each other. We turn next to a consideration of research on migration and the elderly in developing countries.

POPULATION DISTRIBUTION AND MIGRATION

Urbanization

Urbanization is one of the most significant population trends of the second half of the twentieth century. The global population of all ages living in urban areas (as defined by each country) more than doubled between 1950 and 1975, and increased another 55 percent from 1975 to 1990. By the early 1990s, 45 percent of the world's population, some 2.4 billion persons, lived in urban areas. Nearly three-fourths of the population in developed countries was urban, compared with slightly more than one-third in developing countries. The urban population in developing countries is growing about 4 percent per year, much more rapidly than in developed countries (less than 1 percent per annum). Although the urban growth rate in most world regions has begun to decline, some parts of the globe (especially Africa and South Asia) are just now experiencing peak rates of urban growth. In spite of declining rates of growth, the world's urban population is projected to increase about 125 percent (to 5.5 billion persons) between 1990 and 2025 (UNDIESA, 1991b).

Because urbanization is driven in large part by youthful migration from rural areas to cities, it influences the age distribution in both sending and receiving areas. Consistent with the worldwide trend toward increased urbanization, the elderly population became more concentrated in urban areas during the 1970s and 1980s. In developing nations, which still are predominantly rural, slightly more than one-third of persons aged 65 and over reside in urban areas. This proportion is expected to exceed one-half by the year 2015 (UNDIESA, 1991a). In spite of the increasingly urban nature of today's elderly populations, rural areas remain disproportionately older than urban areas in most developing (and developed) countries. This differential is a result of the migration of young adults to urban areas and, in some cases, of the return migration of older adults from urban areas back to rural homes.

The elderly of Africa are more likely to live in rural areas than are the elderly of other regions, even though African populations overall are slightly more urbanized than those in the Asia/Oceania region (excluding Japan; Heligman et al., 1991). The overall trend toward urbanization is stronger in Asia than in Africa, however. Half of the Asia/Oceania elderly are projected to live in cities by 2015, versus 42 percent in Africa. As a region, Latin America and the Caribbean is already highly urbanized. The proportion of elderly in these urban locales is very similar to that of the developed-country average. Unlike the elderly in other developing areas, the elderly in Latin America and the Caribbean are somewhat more likely to live in cities than the general population.

In a study of census data for 29 developing countries (Kinsella and Taeuber, 1993), more elderly women than elderly men were recorded in urban areas in 22 of the 29 countries; exceptions were Bangladesh, Pakistan, and five African nations (Egypt, Kenya, Malawi, Tunisia, and Zimbabwe). Sex ratios (number of men per 100 women) for the urban elderly usually are much less than 100, except in the countries just mentioned. The percentage of all urban females who are aged 65 and over is higher than the corresponding percentage for urban males in most countries. Likewise, the percentage of all elderly women who live in urban areas tends to be higher than the percentage of all elderly men who live in cities.

In some countries the gender differences in urban/rural residence for the elderly are remarkable; 1985 sex ratios for the elderly population in Colombia were 122 in the countryside versus 79 in cities (Kinsella and Taeuber, 1993). Because women live longer than men in almost all countries, sex ratios of less than 100 for the elderly normally would be expected throughout a population. There are, however, more elderly men than women in rural areas in many developing countries. Rural Cuba has an especially large imbalance of 159 men per 100 elderly women. A similar though less pronounced rural male surplus is seen in much of Latin America, which suggests a region-specific pattern in male/female migration that has implications for health and social security systems in both rural and urban areas.

The proportion of elderly men who live in rural areas tends to increase with age. For women, however, the opposite is often true: women 75 years and older are less likely than women 65 to 74 years to live in rural areas, and more apt to reside in urban localities.

There seems to be an emerging consensus that the difference in the level of population aging between urban and rural areas in many developing countries will begin to narrow. Warnes and Horsey (1988) have projected the population of Bangkok in conjunction with that of Thailand as a whole. Their results, under various migration and growth assumptions, suggest that the elderly population of Bangkok will grow more rapidly than that of the entire country beginning around the turn of the century. This change will be due partly to the city's lower mortality rates and partly to the presence of "inflated" cohorts reaching older age. Using different methodologies, Rees (1991) and Watkins and Ulack (1991) reached similar conclusions regarding Zimbabwe's capital of Harare and the Manila area of the Philippines, respectively. Of course, such results are sensitive to the timing and pace of urbanization; Zeng's (1989) projections for China—which incorporate a large level of expected rural-to-urban migration—suggest that urban areas will become and remain younger than rural areas well into the future, in spite of lower urban than rural fertility.

Migration

The volume of labor force migration in developing countries has spawned considerable research in recent decades. Very little attention, however, has been directed to patterns and determinants of migration among older adults, undoubtedly due to a lack of available, comprehensive data.[7] National censuses, the primary sources of information on internal migration, typically obtain mobility information from heads of households and may fail to capture information about other household members. Moreover, census questions concerning spatial movement may be inconsistent from one enumeration to the next (Chayovan et al., 1990) and hence of limited analytic use.

There has, however, been considerable discussion of the consequences of migration for the elderly. A prominent theme is the effect of rural-to-urban migration on family structure and the well-being of the elderly who are "left behind" in rural areas. A commonly expressed concern is that movement of younger adults to urban areas results in the isolation of the aged in rural areas, presumably to the latter's detriment (Goldstein and Beall, 1982; UNDIESA, 1985; Apt, 1992; Gore, 1992). However, the elderly left behind by their children in rural areas may become the caretakers of the grandchildren. This "skip-generation" type of household can be found in rural areas of Thailand and Zimbabwe (Hashimoto, 1991) and in the Philippines (Lopez, 1991). Moreover, family strategies regarding migration to cities may result in a least one adult child remaining behind.

Other concerns are related to the process of aging-in-place in urban

[7] Myers and Clark (1991) provide a useful exposition of five possible stages of migration and spatial distribution of the elderly over the course of the demographic transition.

areas, and to issues of growing old in a new environment without the social network of one's place of birth (Ramos, 1992). Contreras de Lehr (1992) has observed, however, that in Mexico City, where the most prevalent form of family structure is nuclear, there is a tendency in the slums to rebuild the extended family group with available kin; rural-to-urban migrants bring remaining members of their extended family to join them when feasible. Given the high housing costs in many developing-country cities, migration of family units to urban areas may actually be associated with greater multigenerational coresidence than in rural areas, as discussed in the section on family demography.

In addition to internal migration having an effect on the living arrangements of the elderly in developing countries, international migration may also. In Turkey, for example, large-scale migration of workers to Europe and elsewhere has eased national unemployment, but has led to separation of family members. It is unclear whether remittances from abroad compensate for the loss of direct support to the elderly (Tracy, 1991).[8] In some Caribbean nations, years of sustained emigration have contributed to the region's status as the oldest of all developing regions of the world (Kinsella and Taeuber, 1993). Here, the ebb and flow of migration have been significant, but to date, effects on patterns of marital status, living arrangements, and savings/consumption among the elderly have not been well documented.

Family structure can also serve as a determinant of migration of the elderly. For example, if more than one child is available, the elderly may circulate from one child's home to another. Such a pattern has been noted for China (Chesnais and Wang, 1990; Goldstein et al., 1990[9]); India (Caldwell et al., 1984; Vatuk, 1982); the Philippines, especially among poorer families (Lopez, 1991); and Taiwan (Chan, 1992). Moreover, as reflected in the earlier discussion of sex ratios of the elderly in urban and rural areas, a variant of rural-to-urban migration arises when older women migrate to cities to join their children after the deaths of their husbands. Hugo (1991) noted that Indonesian widows, unlike widowers, tend to remain in or migrate toward urban areas. Thus the difference in residential concentration between elderly men and women appears to be related partly to stages in the life-cycle. Elderly women are much more likely than men to be widowed and are more likely than men to have chronic illnesses. Urban residence

[8] See Hugo (1991) for a discussion of the issue of internal migration of children and remittances to the elderly. There is evidence that remittances are an important source of support for the elderly; however, Sorenson (1986) argues that elderly left behind in Korea prefer getting by on their own resources and having a financially independent branch of the family set up in the city. They rely on remittances only for special circumstances, not for daily expenses.

[9] Living "by turns" with different sons was thought to occur in the past after the older generation's estate had been divided among the sons.

may give elderly women, especially widows, the support benefits of closer proximity to their children and to specialized health or social services, but the evidence for this motivation for migration is thin in developing countries.

It also remains to be seen in developing countries, particularly those with sizable middle classes, whether a second developed-country pattern of migration will emerge. Besides "moving for support," the elderly may "move for amenities," such as warmer weather, quieter surroundings, or lower costs of living (see Ikels, 1991, on China). In developed countries, such migration is sometimes linked to retirement, and there is also some evidence of such a link in developing countries (see Becker, 1991, on Africa;[10] Hugo, 1991, on Indonesia), although Machado and Abreu (1991) find no retirement peak in migration for Brazil. In many developing countries, retirement is less of an event and more of a process of gradual withdrawal from the labor force, so the age pattern of migration may not be so marked.

ECONOMIC ACTIVITY AND WELL-BEING

Labor Force Participation and Retirement

Labor force participation declines markedly as persons approach retirement age in industrialized countries. The proportion of elderly who are economically active[11] is often a small fraction of the corresponding proportion of persons 25-54 years. In most developing countries the situation is quite different. Although economic activity rates also decline with older age, they rarely reach the low levels seen in developed countries, and differences among age groups are much smaller. The predominantly rural character of many developing economies means that relatively small proportions of the population are in wage and salaried employment, so most are not affected by compulsory retirement ages.

In a 50-country study (Kinsella and Taeuber, 1993), recent labor force participation rates for elderly men (aged 65 and over) in developed countries were seen to range from less than 2 percent in Austria (in 1988) to 24

[10] Becker notes that returning to one's home village is motivated by a desire to reassert property rights, as well as to have access to the care and resources of kin, who may have earlier benefited from remittances.

[11] The labor force or economically active population in a given country is usually defined as all persons who are working, actively seeking work, or temporarily out of work because of illness, layoff, vacation, strike, and so forth. The time referent for such activity may vary, however, as may the inclusion or exclusion of certain categories of workers (for example, persons engaged in home duties). Such differences in national reporting schemes have an effect on measured labor force participation rates, especially for women and the elderly.

percent in Norway (in 1989). With a few exceptions (Uruguay, Cuba, Singapore, and Argentina), rates in developing countries varied from 30 percent to a high of 85 percent in Malawi (in 1987). Half or more of elderly men were economically active in the 1980s in countries as diverse as Liberia, Bangladesh, Guatemala, the Philippines, Mexico, Indonesia, Pakistan, and Jamaica.

Among women, participation rates ranged from 1 percent in some developed countries to 29 percent in the Philippines (1989). Rates generally are higher in developing than in developed countries, but vary enormously among the former. For example, 72 percent of elderly women in Malawi are said to be economically active, compared with less than 1 percent of elderly women in Egypt. Of course, reported activity rates are influenced by the nature of work itself in many developing countries. There are large concentrations of older workers in agricultural and related sectors. In some countries, a large majority of older workers are self-employed. Various studies (e.g., Holden, 1978; PAHO/AARP, 1989) have shown that definitions of economic activity in both developed and developing countries often exclude major segments of the work that women do. Many argue that such work should be included in national accounts of economic activity. Moreover, depending on which household member is the respondent to the survey or census, perceptions and thus reports of women's economic activity may differ.

An analysis of aggregate labor force participation rates circa 1980 in 150 countries (Clark and Anker, 1990) showed that nations with high national income per capita tended to have the lowest participation rates for men and women 55 years and older. (See Durand, 1975, for earlier research on this topic.) An implication is that as a nation develops economically, labor force participation rates of older persons decline, but there are exceptions to this pattern, for example, in South Korea from 1975 to 1989 (Kinsella and Taeuber, 1993). Variations in labor force participation among countries highlight the effects that cultural values, governmental policies, and economic conditions exert on economic activity levels of older workers.[12]

Despite a worldwide trend away from employment in agriculture, jobs in this sector remained in the 1970s and 1980s the most important source of employment for the elderly in developing (and most developed) countries. Available data from the 1980s indicate that between 75 and 90 percent of all elderly workers are engaged in agriculture in numerous African and

[12] Multivariate, cross-sectional analyses of labor force participation of individual older adults have been attempted by using data from the first WHO surveys in Asia and the Pacific (Agree and Clark, 1991; McCallum, 1992). Both studies find significant country-specific or ethnicity effects.

Asian nations, with considerably lower proportions in Latin America and the Caribbean (Kinsella and Taeuber, 1993). The relatively few time series by age generally show declining proportions of older workers in agriculture, although in Turkey the proportion in agriculture increased slightly but steadily from 86 percent in 1970 to 90 percent in 1985.

Manufacturing activities usually occupy the second largest group of elderly workers in developing countries, though the levels rarely exceed 20 percent. In some Southeast Asian nations, sales positions rank second to agricultural jobs among elderly workers. Proportions of elderly workers in the service sector are still quite small, with the notable exception of Singapore (24 percent).

Formal retirement with pension benefits is much less common in developing countries than in developed countries, and pensions are frequently available only to former civil servants and employees of large private firms in the modern sector.[13] The concept of retirement is foreign to most rural elderly. Where mandatory retirement ages do exist in developing countries, primarily in the urban, formal sector, they tend to be lower than in Western industrialized nations (age 55 is not infrequent, especially for women; U.S. Social Security Administration, 1992). One reason may be the lower life expectancy in some of these countries, but it could also be that in countries with still relatively rapid population and labor force growth, early retirement may represent a substitution of jobs for youth for jobs for older workers.

There has been little multivariate analysis of the retirement process in developing countries (see LeGrand, 1989, on Brazil, and Hayward and Wang, 1991, on China). However, survey responses to questions about reasons for stopping work reflect many of the same reasons as in developed countries. In the Philippines and Singapore, almost half of the males ages 60 and over who were no longer working cited having reached the retirement limit. In Indonesia and Thailand, the percentages were only 28 and 10, respectively. In Thailand, three-quarters mentioned ill health, as did almost one-half in Indonesia and the Philippines, and one-quarter in Singapore (Chen and Jones, 1989).

Economic Well-Being and Pensions

Little evidence exists on the income or wealth of elderly individuals or of households with elderly heads, due to the difficulty of obtaining accurate

[13] The exception is Latin America; pension programs for the self-employed and those in rural areas are common in Brazil, Argentina, and Chile (Williamson, 1992).

(or any) responses to survey and census questions on these issues. Even if respondents were willing to report incomes, several factors complicate data gathering: seasonal variations in income; self-employment in agriculture; the extent of the informal or nonmonetized economy in many countries; and the frequent pooling of household resources. Surveys have had more success in collecting data on sources of income, type of housing, and household possession of consumer durables, but these types of data do not address the issue of the extent to which older people control economic resources, an issue of some importance for their status and well-being (Simmons, 1945; Martin, 1990; Kwong and Cai, 1992).

Data on main source of support from the ASEAN elderly surveys[14] (Chen and Jones, 1989) indicate that only males in Indonesia and Thailand rely most on their own salaries or business incomes. For females in these two countries and for both sexes in Malaysia and Singapore, children and grandchildren are the most important source of support. The proportion relying on pension income ranged from 1 percent among females in Singapore and Thailand to 16 percent among Malaysian males. A similar pattern of reliance on families more than work or pensions can be seen in the data on Korea, Malaysia, and the Philippines from the WHO survey program (Andrews et al., 1986).

Data on income support from the 1987 Nationwide Sample Survey of the Elderly in China indicate striking differences between urban and rural areas. In cities and towns, the proportions of the 60-and-over population who relied on retirement pay were 56 and 48 percent, respectively. Economic support from children ranked second (22 and 28 percent), and support from spouse third (13 and 14 percent). Thus these three mainstays constituted about 90 percent of elderly support. In rural areas, the picture was quite different: 68 percent relied on children, 26 percent were self-supporting from their own labor, and 5 percent received support from spouse. Half of all rural respondents said they had "no say" in their family economic decisions, versus less than 20 percent in cities and towns combined (Tian, 1988).

In general, the importance of pensions for economic support of the elderly is greater in Latin America and the Caribbean than in Africa and most of Asia. For example, about 90 percent of males and 70 percent of females age 65 and over in Argentina, and more than 60 percent of both sexes in Guyana, receive some form of pension (Pan American Health Organization, 1989a,b). Some Latin American nations have had social security systems in place for more than 50 years, as well as schemes that cover certain rural and/or self-employed workers in addition to persons in the

[14] Data from the Philippines on this issue are not available.

more modern sectors (Williamson, 1992). However, current economic realities often limit the benefits to retirees. Most Latin American social security systems are funded by a tax on formal sector labor, which in some countries represents a small base and everywhere is subject to contraction during periods of economic reversals (McGreevey, 1990). Initiatives to ensure the economic well-being of the elderly may conflict with structural adjustment policies to reduce rather than increase public expenditures. As a result, benefit levels often lag behind inflation. Increasingly in Latin America—where growing numbers of elderly have become eligible for old-age pensions—there has been a decline in the purchasing power of pensions and a severe deterioration in many older persons' standards of living (Hoskins, 1991). In Argentina, for example, the nearly 3.5 million retirees are supposed to receive pensions amounting to between 70 and 82 percent of their former salaries. In reality they now receive about half that amount, and their purchasing power erodes further as inflation continues. A retired couple in Buenos Aires, both of whom receive the minimum benefit, takes home less than half of the city's poverty-line income.

Even so, there is some hope that public pensions will provide greater support to the elderly in the future. Although only small proportions of Asian elderly rely on pension income today, increasing proportions of the current labor force are participating in pension plans, so greater proportions of the elderly in the future will be fully vested in such plans. Government officials, however, are concerned about premature overreliance on public pensions and are emphasizing the necessity of strengthening families' support of the elderly (Martin, 1991). Moreover, it is likely that as population aging continues it will be necessary to raise ages of eligibility for pensions to preserve the systems' fiscal viability, as has been proposed in Japan and Singapore, and implemented in the United States.[15] No doubt there would be pressure to accompany such increases in eligibility ages with increases in mandated retirement ages. The alternative would be to raise taxes on younger workers, as long as they remained plentiful, while maintaining relatively early ages of eligibility and retirement.

DATA COLLECTION AND RESEARCH CHALLENGES

A considerable amount of data on the elderly in developing countries has already been collected, as we discuss in detail in the appendix. Much of it has been underutilized thus far. Researchers have limited access to census data, and many of the published tabulations of census data provide

[15] Some Latin American countries, for example Chile, have begun to move towards fully-funded systems (Long, 1993).

insufficient age detail or may be of questionable quality. Some of the survey data on the elderly are slowly finding their way into the public domain (e.g., the early WHO Regional Office surveys), but most are still generally not available even though they may have been collected more than 5 years ago. The lack of research on aging in Latin America (beyond the first-rate work continuing to be done on the epidemiological transition by Mexican scholars and the work on Brazil by Ramos) is surprising, given the region's relative advancement in the demographic and epidemiological transitions; increased availability of the Pan American Health Organization data sets would no doubt stimulate work in this region. There is also still much that can be accomplished worldwide in the analysis of existing data from surveys based on a broader age range (e.g., household expenditure and labor force surveys), and existing time series of census data can be used for cohort analyses of transitions.

Even so, there has been considerable interest in collecting new data, especially in light of the ever-changing characteristics and circumstances of elderly populations, the refinement of the research questions being asked, and the development of new analytical techniques. Some researchers have been concerned that each new data collection effort will end up reinventing the wheel and not benefit from lessons from past experiences.

On the basis of that concern, in 1987 the principal investigators of the first WHO Regional Office project and the ASEAN project were invited to a conference in Singapore, where they and other experts were asked to discuss what they had learned about the methodology of surveys of the elderly in developing countries (East-West Population Institute, 1987; Liang and Whitelaw, 1987; Clark, 1989; Martin, 1989a). Among the basic issues raised was how to define old age in developing countries, where life expectancy may be less than 60 or 65 years, the definition often used in research in developed countries. In some countries, given the relatively small percentages of the population over 60, for example, there can be difficulty in locating sufficient numbers of respondents of that age and higher. Also complicating matters is the fact that the quality of age reporting is suspect in many places. Moreover, as in household surveys of the elderly everywhere, there is likely a bias in the samples toward the relatively healthy, in both physical and mental terms.

For cross-national surveys, there are challenges of achieving comparability in questionnaire design. Beyond the issues of translation are those of the appropriateness of particular questions in specific cultural and socioeconomic settings. The wholesale borrowing of instruments developed in Western settings may lead to problems, such as trying to test cognitive functioning by asking illiterate respondents to copy a design with pencil and paper when they have not had experience handling writing instruments, or asking about age of retirement in places where withdrawal from economic activity is a process rather than an event. Beyond the issue of cross-cultural applicability of specific questions is concern about whether the questions and the answers have the same meaning across cultures. Cultural influences on reports of health status have especially been the focus of debate recently (Johansson, 1992; Riley, 1992).

Given the interrelatedness of the economic, social, and physical well-being of the elderly, there is also a need for researchers in various disciplines to learn from each other, which is undoubtedly true in more developed countries as well. Many of the surveys that emphasize health issues may give short shrift to social and economic issues, and may yield data that provide only the numerators for the rates that demographers typically like to analyze. Similarly, demographers and other social scientists are just beginning to learn about how they might best measure health, given the limited amount of time that can be devoted to health questions in their surveys.

Despite these problems, progress has been made in collecting and analyzing baseline information for the elderly in many developing countries. As noted in the appendix table and discussed in the appendix, East and Southeast Asia have probably received the most attention, which is appropriate given their relative advancement in the demographic transition. Of course, Latin America is similarly advanced, but relatively little research has been done. Trailing even further behind demographically, but probably ahead of Latin America in research, are Africa, the focus of so many ethnographic studies, and South Asia (see Martin, 1990, for a review of research, which has been based primarily on small-scale surveys).

In the previous sections, we have identified many unanswered questions. Little is known about the income and wealth of the elderly in developing countries, and how their economic needs interact with social and health factors to generate dependency. More multivariate analysis of labor force participation and retirement would be helpful.

To understand the support available to the elderly from their families, information on the full kin option set needs to be collected, and data collection and analytical strategies regarding exchanges need to be refined. Although multivariate analysis of living arrangements of the elderly has dominated the work in family demography, there remain questions about the relation of living arrangements to health, housing costs, desire for privacy, and characteristics of the younger generation. Particularly underresearched are transitions in and out of institutions. Related to living arrangements is the migration of both the young and the old. There has been little analysis of the determinants of migration of the elderly, and of special interest is the extent to which they move to join their children in urban areas.

Questions on self-perceptions of health and the ability to perform activities of daily living are typically included in population-based surveys of the elderly in developing countries, but additional refinement of survey instruments is required to reflect more accurately the daily circumstances in particular developing-country settings and cultural differences in attitudes toward health. Particularly needed is research on the socioeconomic factors associated with health and on the predictive value of self-perceptions for subsequent utilization of health services and mortality. Also deserving attention is how risk factors, functional status, and morbidity change over time.

Longitudinal data collection would help illuminate many of these issues, as no doubt would the combination of qualitative with quantitative data collection strategies. Research on aging in developing countries is a growth industry, stimulated both by the policy development process in those countries and by the curiosity of Western scholars about the aging process in different settings. Although Latin America and East Asia are further along in their demographic transitions, all of these societies must make decisions about how to respond to the needs of the elderly and how to make use of their strengths in settings where public resources are limited. Critical for policy development are a better understanding of those needs and strengths, how they are likely to change in the future, and how nongovernmental sources of assistance can best be supplemented by governmental initiatives.

APPENDIX

Data for the study of the demography of aging come from sources similar to those used in research on fertility (i.e., household surveys, censuses, vital statistics, and ethnographic studies, as well as other qualitative data collection efforts). As in fertility research in developing countries, program-related statistics have not yet been widely used. In this appendix we highlight major data collection efforts of each type. In the body of the chapter, we have commented more broadly on the challenges of gathering data on the elderly in developing countries.

Household Surveys

Receiving the most attention have been the cross-national household surveys of the elderly in developing countries, the first of which was the 1984 World Health Organization four-country study of Fiji, Korea, Malaysia, and the Philippines. These surveys were designed by health professionals but have yielded fairly usable data for demographic purposes (for the survey design and basic cross-tabulations, see Andrews et al., 1986; for research based on the data set, see Manton et al., 1987; Martin, 1989b; and Agree and Clark, 1991). As indicated in the appendix table, there soon followed the cross-national efforts of the Association of Southeast Asian Nations (Chen and Jones, 1989), which was led by demographers and the Pan American Health Organization (PAHO), which emphasized health issues. Additional analysis and follow-up data collection for three of the ASEAN countries, plus a new survey of the elderly in Taiwan, was undertaken in 1989 by a group coordinated through the Population Studies Center at the University of Michigan, and has yielded an impressive series of working and conference papers. The PAHO data set has not been exploited to our knowledge, beyond the publication of basic tabulations in a series of country reports. Most recently, there have been two other WHO-sponsored comparative survey projects, one in WHO's so-called Southeast Asian region and one in its Eastern Mediterranean region. The appendix table lists the countries included in those studies.

In addition to these and other cross-national survey programs, there have also been individual national-level surveys of the elderly, as indicated in the appendix table. It has also been possible to base aging research on household surveys of a broader age range of the population, including labor force and income and expenditure surveys, although to date these sources have yielded little published work. Such surveys of multiple age groups have the advantage of not looking at the elderly in isolation. Most notable has been the research based on the family life surveys undertaken under the auspices of RAND in Malaysia in the 1980s (Chan and DaVanzo, 1991) and currently in Indonesia. WHO-sponsored disability surveys have been used to investigate the disablement process associated with aging in India and Indonesia (Manton et al., 1986), and physical examination surveys in Colombia, Egypt, and Uruguay in the 1970s and 1980s have provided information on morbidity and risk factors associated with chronic diseases (Murray et al., 1992a). Data from the household samples of six World Fertility Surveys fielded in Latin America in the mid-1970s allowed analysis of living arrangements of the elderly (DeVos, 1990), and the Living Standards Measurement Surveys of the mid- to late-1980s, which were supported by the World Bank in countries including Côte d'Ivoire, Ghana, Jamaica, and Peru, have also been used to do research on the elderly (Deaton and Paxson, 1990, who use data from Côte d'Ivoire; Strauss et al., 1992, who use data from Jamaica).

Censuses

Data from censuses have not been so widely used in studies of population aging in part because of restricted public access to such data. Public-use data tapes are generally not available from developing countries. To the extent that researchers must rely on published data sets, analysis has been limited because of the lack of age detail above age 65 in many of the published census tabulations (see Martin, 1987). Hermalin and Christenson (1992) have illustrated how census data with older-age detail can be used to analyze transitions in the life course of the elderly and to project changes in the composition of future elderly populations. For example, they have investigated retirement transitions and projected future educational composition of the elderly, as well as the number of children ever born to future cohorts of elderly women.

Vital Statistics

Vital statistics data have also not been widely used in the study of population aging in developing countries. Of greatest interest, no doubt, would be data on numbers and causes of deaths. However, registration of deaths and certification of cause of death are relatively good only in Argentina, Chile, Costa Rica, Cuba, and Uruguay in Latin America; in Hong Kong and Singapore in Asia; and in no countries in Africa. In some countries, data from sample registration systems (e.g., India), disease surveillance systems (e.g., China), and population laboratories (e.g., Matlab in Bangladesh, see Rahman et al., 1992, for an application) can be used in lieu of vital registration data, but even so it has been estimated that only about half of the deaths in developing countries end up in WHO statistics on cause of death, a major source for cross-national research (Bulatao, 1993). Moreover, at least in Latin American populations, there is substantial exaggeration of age at older ages, so estimates of mortality based on these data may require adjustment (Dechter and Preston, 1991).

Ethnographic Studies and Other Qualitative Data Collection

As mentioned in the introduction, anthropologists appear to have been ahead of other social scientists in their focus on aging and the elderly in developing countries. Their interest in the topic continues today, as indicated by the majority of the papers published in the *Journal of Cross-Cultural Gerontology,* which was founded in 1986 and is managed out of the anthropology department of Case Western Reserve University. Given the dearth of studies on aging in Africa that are based on survey and census data, the fact that a substantial proportion of the ethnographic studies appear to focus on Africa helps fill a major gap.[16]

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[16] See especially the October 1992 issue of *Journal of Cross-Cultural Gerontology,* which focuses on gender, aging, and power in sub-Saharan Africa. Also see Keith (1992) for a recent review of anthropological research on family support of the elderly around the world. Less qualitative approaches to research on Africa are taken by Deaton and Paxson (1990) for Côte d'Ivoire; Adamchak et al. (1991) for Zimbabwe; and Apt (1992) for Ghana.

At least two cross-national comparative projects have attempted to combine both quantitative and qualitative data collection strategies. The 1987-1988 United Nations University study of social support systems for the elderly in Brazil, Egypt, India, Korea, Singapore, Thailand, and Zimbabwe used community surveys, focused interviews, and participant observation (Hashimoto, 1991). In the University of Michigan-based study of the elderly in the Philippines, Singapore, Taiwan, and Thailand, information from focus groups of elderly persons and of adult children is being used to supplement quantitative data drawn from censuses and surveys (Knodel et al., 1990, 1992b).

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Appendix Table Surveys of the Elderly in Developing Countries

Country	Survey Name	Sponsoring or Primary Organization	Survey Year	Coverage[a]
Cross-national				
Indonesia	Socioeconomic Consequences of the Ageing of the Population	Association of Southeast Asian Nations	1986	Java
Philippines			1984	Three provinces and Manila
Malaysia			1986	Three states
Thailand			1986	National
Singapore			1986	National
Philippines	Health and Social Aspects of Aging	WHO Regional Office for the Western Pacific	1984	Tagalog
Malaysia			1984	Peninsular
Korea (South)			1984	National
Fiji			1984	National
Bahrain		WHO Regional Office for the Eastern Mediterranean	1989	
Egypt			1989	
Jordan			1989	
Tunisia			1989	
Indonesia		WHO Regional Office for South East Asia	1990	Central Java
Korea (North)			1990	Three regions
Myanmar			1990	Ethnic Bamar
Sri Lanka			1990	Western Province
Thailand			1990	Bangkok + four regions
Trinidad and Tobago	Profiles of the Elderly	Pan American Health Organization	c. 1985	National
Guyana			1984	Capital
Argentina			1985-1986	Urban
Costa Rica			1984	National
Chile			1984-1985	Urban
Barbados				
Brazil				
Colombia				
Cuba				
El Salvador				
Honduras				
Jamaica				
Venezuela				

Number of Respondents[a]	Age Group, Comments (especially if sample nonrandom)
4,500 households	Households stratified by type of economic activity Household had respondent aged 55 or older
1,321	60+; provinces selected on basis of major language
1,254	55+; based on census frame; random
3,246	60+; also 2,111 persons 15-44 re attitudes toward elderly
1,013	60+; Two companion surveys: (1) elderly in institutions; (2) elderly sick in community
830	60+; Tagalog region = 10 provinces and metropolitan Manila
1,001	60+; purposive sample
977	60+
769	60+; purposive sample
	60+
	60+
	60+
	60+
1,202	60+
1,150	60+
1,221	60+
1,200	60+
1,199	60+
875	60+
542	60+; Georgetown and its suburbs
3,058	60+; urban areas of 500,000+
1,154	60+
1,562	60+; urban areas of 100,000+

Country	Survey Name	Sponsoring or Primary Organization	Survey Year	Coverage[a]
China	Emerging Issues of the Aging of Population in Selected ESCAP[b] Countries	U.N. Economic and Social Commission for Asia and Pacific	1987	Four localities
Korea (South)			???	Four areas
Malaysia			1987	Melaka
Sri Lanka			1987	National
Chile	Aging and Dementia	WHO	1992	Mixed
Nigeria			1992	
Costa Rica	Determinants of Healthy Aging[c]	WHO	c. 1993	
Indonesia			c. 1993	
Israel			c. 1993	
Jamaica			c. 1993	
Thailand			c. 1993	
Zimbabwe			c. 1993	
Brazil	Osteoporosis[c]	WHO	c. 1993	
China			c. 1993	
Hong Kong			c. 1993	
Jamaica			c. 1993	
Nigeria			c. 1993	
National				
Barbados	Social and Economic Circumstances of the Elderly	University of the West Indies	1982	National
China	Survey of Aged Population	Five University Population Institutes	1986	Five locales
China	Survey of the Aged	CASS Population Institute[d]	1987	National
China	Cognitive Impairment	University of Illinois	c. 1988	Shanghai
China	Support Systems for the Elderly	China Research Center on Aging	1991	12 areas
Hong Kong	Health Survey of the Elderly	University of Hong Kong	1989	National

Number of Respondents[a]	Age Group, Comments (especially if sample nonrandom)
541	60+; purposive; two localities in Jilin Province, one in Shanghai City, one in Shanghai County
798	60+; three urban and one rural area; 91 intensive interviews
372	60+; random sample in West Peninsular state of Melaka
317	60+; purposive
5,000	55+; longitudinal; four developed countries also in survey;
5,000	studies now in the field
	55+; longitudinal; sample sizes and strategies still to be determined; country list includes Italy
5,000	50+; to include case-control, cross-sectional, and
5,000	longitudinal studies
5,000	
5,000	
5,000	
414	65+
NA	One per 1,000 sample survey on aged population (presumably 60+ in localities where universities are located: Shanghai, Hubei, Jilin, Liaoning, Beijing).
36,755	60+; Tibet excluded
5,055	55+; noninstitutional population
20,000	Data not yet released
1,172	55+; self-reported status; includes life-style and social support measures

Country	Survey Name	Sponsoring or Primary Organization	Survey Year	Coverage[a]
India	Survey of the Elderly	Registrar General	c. 1990	National
Korea (South)	Korean Elderly Survey	Korean Institute for Population and Health	1984	National
Morocco	Aged Persons in Morocco	Ministère de L'Artisanat et Affaires Sociales	c. 1984	Seven zones
South Africa	Multidimensional Survey of Elderly South Africans	Human Sciences Research Council, University of Pretoria	1990-1991	National
Taiwan	Youth and the Old Survey	Directorate-General of Budget Accounting and Statistics	1988	NA
Taiwan		Taiwan Provincial Institute of Family Planning and University of Michigan	1989	National

NOTE: Other recent surveys in developing countries that cover other age groups in addition to the elderly, but that are well suited to the study of the elderly include the Malaysia Family Life Survey II and the Indonesia Family Life Survey, both conducted by RAND.

[a]NA = Not available.
[b]ESCAP = United Nations Economic and Social Commission for Asia and the Pacific.
[c]In planning stages.
[d]CASS = Chinese Academy of Social Sciences.

Number of Respondents[a]	Age Group, Comments (especially if sample nonrandom)
NA	60+; results not yet released
3,704	60+; focus on living arrangements and caretaker attitudes
899	58+; sample based on occupation; women underrepresented
4,365	60+
NA	All ages
4,049	60+

Appendix: Letter to Richard Suzman of the National Institute of Aging from the Committee on Population, March 2, 1993

NATIONAL RESEARCH COUNCIL
COMMISSION ON BEHAVIORAL AND SOCIAL SCIENCES AND EDUCATION
2101 Constitution Avenue Washington, D.C. 20418 U.S.A.

COMMITTEE ON POPULATION

TELEPHONE: (202) 334-3167
FAX: (202) 334-3768
CABLES: NARECO WASHINGTON
TELEX: 248664

March 2, 1993

Dr. Richard Suzman
Director
Office of the Demography of Aging
National Institute on Aging
Gateway Building, Rm. 2C-234
7201 Wisconsin Avenue
Bethesda, MD 20892

Dear Dr. Suzman:

This letter responds to your request for the results of the Committee on Population's deliberations about future directions in research on the demography of aging.

As you know, with your support the Committee on Population held a workshop on the demography of aging on December 10-11, 1992. The purposes of the workshop were to examine the scope of the field of the demography of aging, highlight its contributions to policy formulation, summarize principal research findings, and identify areas for future research.

The workshop resulted from a planning process that began with an informal meeting of committee members and other experts in January 1992. At that meeting, participants were asked to identify specific topics and the best researchers in the area of the demography of aging, which is an emerging subfield of both demography and gerontology. Following the meeting, the committee discussed and amended the list of topics and researchers, and we then decided to commission eight review papers for presentation at a December 1992 workshop. (A list of the papers, authors, and paper discussants is appended.) The workshop was attended by the paper authors, discussants, and other researchers and experts from federal agencies.

A volume of the papers, revised to reflect the discussion and suggestions made at the workshop, will be published in late 1993. However, given your need to receive much sooner a summary of promising directions for future research and data collection, the committee has identified research needs and opportunities, based on the workshop papers and discussion and its own deliberations. The published papers will provide a more detailed review of research findings to date and their relevance for policy development, as well as discussion of the strategies for research and data collection outlined below.

Population Projections and Medical Demography

There is considerable debate about the future course of old-age mortality and life expectancy. Improved sex-, race-, and cause-specific data on deaths at older ages are essential for refining mortality and population projections, which can help gauge the future demand that will be placed on Social Security and other programs that support the elderly. There also needs to be a better understanding of how publicly funded universal health insurance programs, such as Medicare, and systems in other countries, e.g., Canada, have affected mortality trends. Both cross-national comparisons of program effects and analysis of health surveys linked with administrative data bases from Medicare and Medicaid could provide valuable insights.

As populations age and life expectancy at older ages increases, there is concern about the relationship between declining mortality and the disability profiles of survivors. Evidence to support the hypothesis of convergence to a biologic limit to life is weak, but there remains considerable uncertainty about the implications of increases in the length of life for a wide range of quality-of-life issues. In order to establish national priorities in health care, it is essential to characterize the effects of changing mortality patterns on the health of the American population. Demographic models that are biologically naive are not useful either for forecasting health changes in a rapidly aging population or for assessing the health burden of this population. Of particular importance are efforts to integrate data from administrative sources (e.g., the Medicare billing files) with those on medical and biological variables from longitudinal surveys. Such complex data systems are necessary to characterize both the trajectory of health transitions in the older population and the costs associated with the mix and distribution of disease states within the population. Improved understanding of these issues is a cornerstone not only for health policy development, but also for analysis of the economic and social well-being of the elderly.

Socioeconomic Status, Health, and Mortality

Although the matching of data from the National Death Index with data from the 1973-1985 Current Population Surveys has provided a rich new source of information on differences in mortality by education in the United States, understanding of how differences in socioeconomic status affect health outcomes is still rudimentary. Research designs that incorporate more information about risk factors, access to health care, social networks, and health histories are badly needed. In particular, there is a need for more research on how access to health care, measured both quantitatively and qualitatively, is associated with socioeconomic status and how they jointly affect mortality and morbidity. In these analyses, attention must be given to the fact that status, especially as measured by income, may be both a consequence and a determinant of health. Greater attention also needs to be paid to the causal role of social psychological variables and to the integration of such variables into economic models.

There is a need to move beyond cross-sectional approaches and use cohort analysis, recognizing that individuals are not mere slices of cross-sectional characteristics but also have variable histories, exposures to risk, and motivations. Of particular interest is how childhood health and economic circumstances contribute to differences in adult health. Better knowledge of the source of socioeconomic differentials in mortality would also help to inform population projections.

Retirement and Labor Force Behavior

The new Health and Retirement Survey (HRS) will provide excellent data on both health and work and allow multiperiod analysis of the behavior and circumstances of older Americans as they approach retirement. Matched data from Social Security records and information from firm retirement and health benefit plans will facilitate consideration of the full range of factors influencing retirement decisions. This NIA-supported data collection effort also will provide much needed data on minorities and women. Of particular promise are those data that will support the modeling of joint decision making by husbands and wives. It is critical to continue this most important endeavor, so that the initial sample is followed over time and that appropriate freshening of the sample is possible.

To understand the influence of different policy environments, it is hoped that international data sets comparable to HRS will become available. There is also a need for more attention to research on the demand for and accommodation of older and disabled workers, which requires research designs that go beyond surveys of older persons.

Income and Wealth

The new HRS, as well as the survey on the Asset and Health Dynamics of the Oldest-Old (AHEAD), will strengthen analysts' ability to assess, explain, and forecast the economic status of the elderly. Data on women and the oldest-old will be especially useful in tracking the changing resources of single, aged individuals, as well as aged couples, and in identifying pathways into old-age poverty. New research based on these data sets should yield a better understanding of precautionary savings behavior and of how older people draw down their assets in relation to changing health and health care expenditures. Continued funding of these data collection efforts will be critical to understanding how the circumstances of the elderly are changing. Because of likely changes in Social Security and health care benefits, longitudinal data collection, through projects such as HRS and AHEAD, can provide opportunities for assessing in a quasi-experimental fashion how the policy environment affects individuals' behavior and decision making.

The HRS and AHEAD data bases will provide useful information on income and asset dynamics, but they will allow only indirect estimation of consumption by older people. Providing estimates of the needs of the elderly and measures of financial distress is an important goal. In particular, research to establish appropriate consumption equivalence scales for single persons relative to couples is needed.

Family Structure and Support

Families are the most important source of nonfinancial assistance to the elderly, and research on family support must take into consideration the characteristics and situations of both the elderly and their kin, whose decisions determine support outcomes. Additional information on family networks, both active and available, needs to be included in survey instruments; the HRS and AHEAD surveys are exceptional in their attention to such detail. Little is known about ethnic differences in family support, and research is needed to assess the effects of changing female labor force participation and the effects of divorce and remarriage on the living arrangements and family support networks of the elderly. A better understanding is also needed of transitions in living arrangements in relation to specific functional limitations and of the consequences of alternative living arrangements for the well-being of the family members involved.

A key factor in family support is the proximity of kin, and more research is needed on the migration decisions of family members in relation to the current and anticipated needs of the elderly and on the role of proximity in the provision of support. To better understand family structure and support, consideration should be given to making entire kinship networks an integral part of sample design.

Public and Private Transfers and Intergenerational Economic Relations

Support for dependent older people can be provided through public programs and private markets, as well as by families, and it can take the form of both financial assistance and labor. Is one type of support more efficient than another? Does the provision of one type discourage the provision of others?

In the case of financial assistance, better understanding is needed of how transfers are related to income and wealth. For family transfers, we need to know more about the motivation for transfers, whether transfers are made directly or indirectly through purchases of services, and the size of both transfers during life and bequests. In both the public and the private domains, greater attention to issues of cohort equity and ethnic differentials is required in the analysis of intergenerational transfers.

The interaction of various sources of support with respect to caregiving needs to be addressed in longitudinal models that include information on changing needs of the elderly and on both family and nonfamily providers of assistance, such as the pool of potential providers, their resources, and the price of services. Research should focus on the intensity, frequency, and duration of caregiving and other forms of assistance, not simply on their existence. Results can provide input to microsimulation models designed to forecast market and family services available to future cohorts of the elderly. As mentioned above, the AHEAD survey of the oldest-old will make considerable progress in ascertaining networks of potential family providers, but because of confidentiality concerns, there as yet is no means of linking these data to detailed area resource files on the supply or price of nonfamily services.

Migration and Population Distribution

Far more research is needed on geographic variations in the concentrations of the elderly, particularly the oldest-old, and the demand for and cost of services provided through state and local governments. Also, international migration is remaking the demographic profile of the United States. In the short term, the immigration of Asians, Hispanics, and others is improving the ratio of workers to retirees, but very little is known about the differences in the dynamics of aging across foreign-born groups. Detailed analyses of both older and younger cohorts of migrants are important, and both need to take selectivity of migration into account.

Developing Countries

The dramatic demographic and socioeconomic changes occurring in many developing countries provide a unique opportunity to study how societies, institutions, and individuals adapt to aging populations. Study of these processes can provide insight into the influences of culture and ethnicity, the changing role of family support, particular effects in low-income environments, and the consequences of new policies and programs. For Asia at least, there is a growing baseline of information on today's elderly, but much remains to be done in collecting data on and analyzing the interrelations among physical, economic, and social well-being and in understanding how the lives of the future elderly will differ from those of today; prospective studies would be especially helpful. Although surveys on the elderly in Latin America have been conducted, the data have not generally been made available for analysis to the broad research community. In both regions, greater use might be made of existing survey and census data that do not focus on the elderly alone but do provide sufficient age detail. Moreover, it is important not to study the elderly in isolation from other age groups. In the development of new survey instruments, particular attention needs to be paid to cross-national comparability and how meaning and interpretation of questions and responses may vary. A better understanding of the daily activities of the elderly and of family structure and roles is needed.

We hope that this summary of the most promising directions for research and data collection in the area of the demography of aging will be of assistance to the National Institute on Aging. We believe that the workshop was successful in achieving its goals, and we appreciate the institute's

Letter to Dr. Richard Suzman
March 2, 1993
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willingness to support it and the Committee on Population's other activities on aging. We will of course provide you with copies of the workshop volume upon publication.

Sincerely,

Samuel H. Preston

Samuel H. Preston
Chair

Enclosures
Committee on Population roster
List of workshop papers, authors, and discussants