General Introduction

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Six hundred million Chinese in 1950, and double that today. Eight hundred million Africans on the eve of the third millennium, and probably three times that in 40 years. Humankind under threat from a third world population *explosion*. Industrial societies enfeebled by *depopulation* and the opposing risk of a *population implosion*. Pension systems hard-pressed by aging populations. Northern societies living in entrenched fear of invasions from the east or south, be it history's *yellow peril* or the more recent *open floodgates* from across the Mediterranean or Rio Grande, turning a convenient blind eye to their own ancestral past as invaders, with their most overwhelming wave (toward North America) being a matter of recent history. For the past 50 years, population issues have dogged our contemporaries and they remain as live an issue as ever.

There is nothing new in this. Populations have been counted since the start of recorded time. But rational scientific methods to do so are of fairly recent date. Back in the 17th century, John Graunt (1662) tried estimating the population of London from registrations of deaths, while the late 18th century found Thomas Malthus publishing the first edition of his *Essay on the Principle of Population* (1798). But it was not until the 20th century that Alfred Lotka (1934, 1939) gave us a general theory of population dynamics, and Adolphe Landry (1934) a general explanation of the *demographic revolution*, which we now call "demographic transition" (Kirk, 1944; Notestein, 1945).

I. SCIENCE AND ITS PURPOSE

The problem with how demographers relate to the public may be that they now have so many different sophisticated tools for analysis that they risk shutting themselves up in an ivory tower of overtechnicality, even to forgetting what their science is all about: population. Too many handbooks give a sterile purchase on demography and, after lengthy expatiation on the relationships of *rates* to *probabilities*, the differences between *occurrence—exposure rates and frequencies*, or even the pros and cons of the n^{th} *parameter* of a descriptive or explanatory *model* of fertility or mortality, stop just where things start to get interesting: explaining the phenomena measured and assessing their impact on other aspects of economic and social life. The aim here is to combine a comprehensive and comprehensible presentation of all these methods of demographic analysis with a discussion of how they can be used to understand general population dynamics and the relationships (causes and effects) between them and their natural, economic, social, political, and cultural environments. In other words, we need to look not only at the science (demography), but also its subject (population) and not just what we can know about the latter, but what we can do with it.

The aim of scientific inquiry is not just to describe the universe and the laws that govern it; but also to try and tell us how it works. What it tells us enables us to act directly on the real world in some areas and change it for our benefit. So, modern physics has given us control of atomic energy and laser beams and medicine has produced antibiotics. In other areas (meteorology and astronomy, for example), science has only—at least as yet—enabled us to predict certain developments so that we can better accommodate them. For some scientific topics, we must be much less ambitious and content ourselves with describing past or current events and trying to understand their root causes. This, surely, is where we must class economics

and politics, with the caveat that these disciplines are firmly geared toward action and control of the material world and the future, whereas the ultimate goal of science, regardless of performances, is to increase humankind's ability to take its own destiny in hand. Where does demography stand in this? Is it predictive? Can it be used for action?

Knowing, understanding, predicting, and controlling population development . . . Can this be done in isolation from other disciplines like history, geography, economics, sociology, psychology, medicine, biology, and genetics? Absolutely not. But, attempting to include every discipline would be as doomed to failure as would limiting our study to the techniques of demographic analysis alone: Co-opting everything potentially related to demography would lead us off course and risk muddying the paths we are trying to clarify.

The term "demography" first appeared in a work by Achille Guillard (1855), "*Eléments de statistique humaine ou démographie comparée*." Although more of a crusading pamphlet than a scientific discourse, and offering too narrow a definition, he must at least be credited with having coined the word used to describe the discipline today. But, it was more a late baptism than a birth. The foundations of the scientific edifice of demography were laid in the 17th and 18th centuries by a series of scientists working along the same lines: England's John Graunt (1662) and Edmond Halley (1693), Germany's Peter Süssmilch (1775), Holland's Willem Kersseboom (1742; INED, 1970), France's Antoine Deparcieux (1746), Sweden's Per Wargentin (1766). This nascent science as yet had no clear name or object. It was often referred to as *political arithmetic*. In fact, while its founding fathers came from quite different backgrounds (a cloth merchant, an astronomer, a theologian, an actuary, and two mathematicians), they agreed on at least one point: the need to address their *political* problem (the study of human populations) with *numerical* sciences—mathematics, statistics, and probability theory. And, that is precisely what Achille Guillard meant by linking his neologism with the expression *elements of human statistics*. We, too, must start by reducing reality to calculable and measurable elements in order to describe, analyze, and understand the mechanisms that govern the composition and development of a population. This is the foundation on which Alfred Lotka (1939) developed his general theory of *population dynamics* and this process is central to demography, even if it also seeks to study the dynamics of population from all angles connected with the various qualitative and quantitative aspects of the population at both individual and societal levels.

II. HUMAN POPULATIONS

What populations are we referring to? This is not a trivial question because in strictly statistical terms, a *population* is generally defined as a set of unspecified individual elements meeting a single definition. Once that group becomes subject to an ongoing process of entries and exits capable of changing its size and structure, it can be studied with the tools of demographic analysis. In this way, one can just as easily calculate the life expectancy of a *population* of electric light bulbs as measure the fertility of a *population* of butterflies, and so study the overall dynamics of these specific populations. *Animal population studies* in particular are a special field in which the principles of demography are widely used. Nevertheless, we exclude it from our area of study by limiting our discussion to human populations only. This is less because *human demography* is already a broad enough field in itself to be the subject of encyclopedic treatment than to highlight its singularity: Humans are not just statistical units, simple living beings, or merely social creatures like bees and ants; in Aristotle's[1] phrase, man is a *political animal* thinking and influencing his or her own individual and collective destiny, which situates the study of human population dynamics clearly in the field of social sciences rather than biology.

The most easily defined human population is all the human beings inhabiting the earth: All humanity, taking the term "humanity" in its full demographic sense of not just all human beings alive today, but also the entire course of the history of settlement, which is the core issue of population dynamics. Here, population dynamics relates only to one kind of entry and exit: births and deaths. But demography can just as easily apply to a small part of that group, set apart by reference to one or more criteria by which the individuals selected to form part of it can be identified: territory, religion, language, nationality, education, economic activity, disease, sex, blood group, and so forth. Any group thus defined can constitute a *population* in the demographic sense of the term. In many cases, the dynamics of this population will then be

[1] In his "Politics" Aristotle (384–322 BC) was seeking to emphasize the sophistication of humankind's social organization, embodied in the organized state. As Marcel Prélot (1961, p. 6) puts it: "Ancient man, as Aristotle defined him, was only a being or 'creature of the city.' The import of the definition is severely curtailed by translating 'zoon politikon' as 'social animal.' Animals are also social, but only man is political. His nature is not to live in flocks, herds or hordes but as an integrated part of that social organization represented by the Polis, the City; which is, for him, both a natural need and an ideal."

governed by more complex rules, according to many different types of entry and exit. In addition to the *natural changes* of births and deaths, we must take into account other events through which the individual characteristics defining the group studied are acquired or lost: crossing a border, acquiring or losing nationality, taking up or leaving an occupation, illness or cure, and so forth, unless they are (biologic or other) characteristics acquired through birth and lost only with death (gender, blood group, birthplace, etc.).

Of all the criteria used to identify a subpopulation whose dynamics are a matter for demographic study, the most important is residence in a socially significant territory. First, it must correspond to the simplest definition covering all humankind, which is self-defined by residence on a territory (the planet) whose social significance is beyond question in these times of globalization, the only difference being that this territory represents the entire area so far inhabitable by humankind. In addition, the concept of territory is inseparable from the social organization of human life, taken here as a building block of the subject of demography. So, territory is not just about geographically bounded areas—the area concerned must still be connected with the organized community life of human beings. Admittedly, the boundaries of that area may be determined by strict physical geography (the population of the Andean plateaux or the middle Senegal valley, for example) but the significant fact is that the ecologic conditions governing these territories influence the collective way of life. Consider too that these ecosystems are not the only source of socially organized territories: remember how many states of the United States are delimited by imaginary lines representing latitudes and longitudes!

III. POPULATION DYNAMICS

Whatever the population studied, demography focuses on its dynamics. Although it may attempt to identify the determinants and assess the impacts in the economic, social, cultural, political, and other fields, these factors and impacts fall within its purview only in so far as they offer explanations of these dynamics in view of informing government and society of the implications for the future. However, developing the specific analytic tools to do that has enabled demographers to acquire experience and skills in equally useful fields of study outside the specific focus of the discipline, not directly connected to population dynamics. Mortality, for example, one of the key factors of population dynamics, is obviously related to health and thus is a touchstone issue of demographic research in which demographers were interested even before the word demography was coined. But, the demographic study of health is supremely relevant to the social system and policy makers, be they general government, the medical profession, welfare funds, or charitable agencies. As a result, demographers are encouraged to engage with studies or research on subjects completely independent of the relevance they may have to explaining population dynamics or the effects of growth. For example, having developed abilities to measure morbidity, which has a clear impact on mortality (and hence population dynamics through tuberculosis, cancer, or cardiovascular diseases), the demographer may just as easily be prompted (by a study sponsor or simply to further his or her own scientific interest) to evaluate diseases or disabilities such as the common cold, vision problems, or mental illnesses whose connection with mortality are much more tenuous and in any event not the major concern.

Likewise, marriage entered the ambit of demography prima facie because it was or still is in many societies a factor for formally organizing the expression of fertility. However, it has subsequently remained a subject of demographic inquiry even where the marriage rate and fertility are increasingly uncoupled by the rise in nonmarital fertility and contraception within marriage. Demographers are increasingly working with sociologists, psychologists, political scientists, and lawyers in studying the diversifying forms of marriage, including those that clearly no longer have a link with fertility, such as same-gender unions.

The fact is that anything connected with fertility or mortality, however remotely, can have a direct bearing on population dynamics and it is only well upstream (factors) or downstream (consequences) that it can be considered completely outside the specific field of demographic research.

Migratory moves are another consideration. It is clear that what has just been said about mortality and fertility can readily be applied to external migrations—those across the boundaries of the area in which the study population lives. Internal migrations, which are a zero sum for the population concerned and so do not affect its dynamics directly, are a different matter altogether. Should they simply be excluded from the scope of demography? There are at least three good reasons why they should not.

First, the concepts and methods of analysis of migrations are self-contained, for one very good reason: The same migration flow can be considered as

external or as internal according to how the study population is defined. A migration from Ohio to Oklahoma is an internal migration for the United States, but external for each of the two states concerned. The same argument can be applied at all levels and applies even more so where the study population is defined not by territory but by any other distinguishing criterion (school population, occupation, legal categories, etc.). Occupational, social, and legal migratory moves may be internal or external, depending on the study population profile. Such rapid change in the distinction between internal and external alone would justify including the study of all migrations of whatever kind in the scope of demography.

But, also, even restricting discussion to the strict confines of a given population—in the broadest case of the population of a geographic area—internal migrations are usually not just indirect factors. Rather, they are are also a direct consequence of population dynamics. The spatial reorganization effected through internal migrations, especially between town and countryside or relatively different cultural areas, is rarely without consequence on demographic behavior, health, and fertility. To this extent, internal migratory moves contribute at least indirectly, and often significantly, to the overall movement. But, even more clearly, internal (and external) migrations are often the consequences of population dynamics effects. Population pressure exerted on certain strata or regions of the territory (the countryside, for example, or areas with a higher natural increase) are often the source of internal migration flows, which, as a result, fall within the field of general population dynamics.

For all these reasons, far from excluding internal migrations from the scope of this book, external and internal migrations will be distinguished only according to methodologic or conceptual needs. It is quite clear that although only external migrations are central to the dynamic, internal migratory moves are equally important in studying determinants and consequences and that in the final analysis, they will in most cases be methodologically inseparable.

The division between the components of population dynamics and their relations with other aspects of social dynamics may be unclear, but so are those of the wide range of populations that can be the focus of demographic study. It was said earlier that the focus of this text will be on resident populations living in a socially constructed area, but that is not to exclude other populations susceptible to demographic analysis. However, other examples will be cited only briefly and selectively to illustrate the varied range of possible applications, which is so wide as to rule out a comprehensive approach.

IV. INDIVIDUALS AND VITAL EVENTS

As stated above, demography is about the study of the *human population*, although its techniques can be applied to other subjects. However, any population consists of a group of individuals. While demographic research does not focus on the individual *per se*, unlike psychology for example, demographers must bear in mind the obvious facts that a population's mortality is due to the death of some of its members during a given period, *natality*[2] is the result of births engendered by men and women, and migration stems from the mobility of human beings within or outside borders. The correspondence between population changes and individual vital events, however, is more complex than it appears at first sight. Take the case of mortality, for instance. In any year, an individual may die or survive; so his or her survival probability will be 0 or 1. During the same year, general mortality may be characterized by the ratio of the number of deaths to the population exposed to the risk at the start of the year. This ratio gives a frequency or probability of dying that will never be equal to 0 or 1 other than in the exceptional case of everyone surviving or dying in the year. When we say that a person has a 0.083 probability of dying in the year, we are actually applying a group characteristic to the individual that will *never* occur on an individual level. The fact is that if the person survives during the period of time, its probability of dying will be 0, and if the person does die, it will be 1; it will never be equal to 0.083. An individual probability cannot be estimated unless there are at least two individuals; we then apply to the individual a probability calculated for the group by assuming that the population is homogeneous in relation to the risk of dying. This is the basic principle of life insurance, enabling a measure taken on the population to be transposed to a specific individual.[3]

Another example of the differences between a population and an individual relates to the fact that a person may age comparatively quickly or slowly, but can never get younger. The *arrow of time*, as philoso-

[2] We generally talk of natality in relation to a population, and fertility for individuals of childbearing age.

[3] This principle depends on the concept of probability itself. Do we assume that a probability is the result of a series of identical experiences, where events are repeated in the same conditions (a barely tenable position for human events), or do we instead consider that probability expresses the degree of certainty about the truth of a proposal in the light of the available information? This second "Bayesian" approach seems to correspond more closely to the needs of demography.

phers call it, is a one-way street.[4] But a population can get younger if the birth rate rises. In this case, the proportion of young people in the population will rise (to the detriment of the other age groups) and the mean age of the population will fall. So a population may rejuvenate following a rise in the birth rate even if individual life spans lengthen. Conversely, populations have historically aged as a result of declining fertility and not because the mean life span of individuals increased.

A population is a point-in-time cross-section of a multitude of individual life paths. In a given period of time, people are added to this population through birth and immigration, while others die or emigrate. The total population will increase or decrease as a result of these events. To properly understand the period change in the population, therefore, we need to know how many people were born in the period under review, how many died, and how many emigrated or immigrated (as will be seen in more detail in Chapter 3). The cross-sectional *demographic structure*, therefore, will depend on the characteristics of the individuals comprising the population at that time (e.g., their age, marital status, gender, etc.). *Population change* will result from the number of births, deaths, emigrations, and immigrations occurring in that population during a period of time.

There is an infinite variety of possible demographic structures according to the number of characteristics selected. Individuals do not differ only by age or marital status; they also differ in dietary patterns, musical tastes, hair and eye color, and so forth. Not all of these characteristics and associated structures are useful to demography; only those characteristics capable of affecting population change must be taken into account. So, fertility, mortality, and migration vary with the individual's age, sex, and marital status; but educational level and social or ethnic group often affect an individual's fertility or life span too. On the other hand, a love of tulips or Sibelius symphonies probably has no impact on the components of population change, although these characteristics may be more specifically *associated* with certain social or ethnic groups. Any putative correlation between a passion for tulips and individual fertility would probably be spurious, therefore, and would almost certainly be eliminated by controlling for the social or ethnic group.

Generally, for an individual characteristic to be meaningful for demographic purposes, it must be individually discrete and affect at least one of the components of population change, after controlling for potential common causes. For example, individuals differ in age, and age influences fertility, mortality, and migration. The same applies to gender and many other variables. By contrast, musical tastes may vary from individual to individual, but do not influence population change; any correlation will be eliminated by controlling for *confounding variables* such as social status. Musical tastes may interest sociologists and musicologists, but are utterly irrelevant to demography.

Demographic behavior (i.e., giving birth to a child and dying or migrating within or outside of the area concerned) is clearly an individual characteristic. The aggregation of these events is what produces population and structural changes. The causes of these types of behavior may be physiologic. Sexual desire is important for the reproduction of the species; death is probably imprinted in our genes. Most behavior, however, is learned during life or childhood (i.e., it stems from factors related to the individual's past, family and social environment, and culture). Even gender may depend on assignment and upbringing, such as whether parents and peers treat the child as a boy or girl. This individual gender identification may even lead to pseudo-hermaphroditism (Fantino and Reynolds, 1975). The decisions to get married, have children, and/or migrate are very much dictated by learned behavior, parental and peer influence, social membership, and group culture. Dietary patterns, which have a significant influence on health and survival, are also largely culturally determined, as lovers of snails or frogs' legs will testify! Smoking and drinking, two major causes of death, are also socially conditioned.

Thus, inquiring into the possible causes of demographic behavior means going beyond individual factors and looking at the human being as a member of a household, family, social category, ethnic group, and so forth. In recent years, targeted surveys have enabled demography to sharpen its focus not just on individual characteristics (age, sex, education, etc.) that influence demographic behavior, but also on the multilayered aspects of demographic change stemming from the individual's membership of different networks of groups and institutions.[5] The subject of demographic research, therefore, is the individual *and* the society in which he or she lives. Explanations focused just on individual behavior, like the rational behavior of economic agents beloved of economists, cannot encompass the broad spectrum of influences

[4] Although some philosophers consider the forward march of time to be only a subjective characteristic of life as lived, and not an objective reality; they would argue that time stands still (see, for example, Michael Tooley, 1997).

[5] See D. Courgeau (1996).

and incentives that rule human needs and motives; the same would apply to a purely macrodemographic explanation (see, e.g., de Bruijn, 1999).

As will be seen throughout this book, demographic explanations and theories are increasingly incorporating the social value systems and factors that predicate demographic behavior. This is not to say, however, that all individuals act in an identical manner; even in very homogeneous societies, some individuals adopt nonconformist attitudes and styles of behavior. So, some couples in a low-fertility country may have large families, just as some couples may practice contraception in countries where fertility is highly valued. Nevertheless, behavior in most societies is sufficiently homogeneous for aggregated measurements like life expectancy and average parity to be meaningful.

V. DEMOGRAPHY AND SOCIETY: THE GREAT CHALLENGES

Demographers, therefore, cannot rely only on demographic variables to describe and explain population dynamics. Their conceptual framework must necessarily accommodate all individual and collective factors likely to influence the demographic processes of the individuals—and hence the population—studied.

Recent developments in the field are intertwined with the broader changes wrought to knowledge and practice in all the social sciences by turn-of-the-century political, economic, social, and demographic developments. Society today is in the throes of rapid change, which is affecting some geographic areas and population groups more than others and creating new (social, economic, and demographic) divides or reviving old inequalities. As a result of the rapid pace of social and cultural changes, major technologic advances, the growing power of the market economy, the decline of the welfare state, globalization, adaptability to new situations differs from one population to the other, even within countries, according to their cultures, access to new technologies, and, of course, economic performances. In almost every case, the strongest win out over the weakest. As a result, the gap—including the demographic gap—between the leaders and the laggards is widening. These processes have aggravated the world north/south split, just as economic globalization has widened the welfare divide between an increasingly developed north and the different components of an increasingly riven South. The most dynamic southern countries, which are also those with the earliest onset demographic transitions, have managed to make the best of the situation, and even compete with northern countries, whereas others, resource-starved and still tackling the consequences of overrapid population growth, are sinking deeper into crisis.

Population trends in the wealthy countries could become a new source of concern. The received wisdom that the sweeping historical change represented by demographic transition—the shift from high levels of fertility and mortality to the low levels attained between the two world wars—would be followed by a situation of equilibrium—near-zero growth and unchanging structures—seems not to have to been borne out in reality. Far from stabilizing, the distribution of the population between its three large components that typify the individual life cycle—childhood, adulthood, and old age—seems more fluid now than ever. In the classic posttransition scenario, the population aging that is inherent to the change from pre- to posttransitional stages could have stayed within reasonable enough limits to require only tinkering at the edges with the social systems established over the century; but the collapse of fertility levels and the unexpected decline in mortality among the oldest old is distancing the situation from the accepted model. Furthermore, short-term cyclical reasons have created an unprecedented accumulated potential among northern populations for the demographic aging process to accelerate. Basically, the working age populations have so far remained virtually stable thanks to the size of the post–World War II *baby boom;* before long, however, these large numbers of cohorts will reach retirement age, while the working population dwindles as the less populous cohorts reach working age.

It is easy to predict when the two waves of baby boomers—immediately postwar and the 1960s—will leave the labor force. With retirement ages of 60 or 65, the first wave will start exiting around 2005 to 2010, the second around 2025 to 2035. Logically, this will put immense pressure on health and social protection systems. Here, the veritable revolution in health care brought about by major advances in treatment and prevention, which give most people with degenerative diseases or cancer a longer life expectancy than before, must be taken into account. The possibilities of survival amongst the oldest old are expected to increase considerably in the coming decades, because today's older people—and the next generation even more so—are (or will be) of the generations that have drawn far more of the positive benefits of welfare than their predecessors: proper diet, improved quality of life, occupational health and safety, cultural development, and, especially, the goods and services necessary to stay in good physical and mental shape until entering the oldest age group. The increased number, and espe-

cially proportion, of the old elderly, however, will begin to push up not only social protection but also health costs: the prevention and treatment of chronic and degenerative diseases, assistance for disabled people, and, more generally, care for very old people with physical and mental disabilities. So, demographic analysis must accommodate not only declining mortality and lengthening life expectancy, but also the development of different disease patterns and morbid conditions affecting the population.

Entrenched very low fertility also has a major bearing on the increase in the proportion of old people. Basically, where the top of the population pyramid gets wider under the effect of increased longevity, the bottom part narrows each year with the declining birth rate. Furthermore, that low fertility is itself the result of shrinking generations, because women born after the baby boom and falling birthrate are now the childbearing-age generation: Even supposing an average parity equal to that of their mothers, these women would produce fewer children in total than preceding generations. Fertility decline thus creates a dual cause of the falling birthrate. Were this knock-on effect to continue, it would produce an inescapable decline in the total population. Although immigration might provide a stopgap solution, only a significant rise in fertility can halt the process in the long term. The steadier the decrease in the youngest cohorts entering at the bottom of the pyramid, the harder it will be to turn the situation around and the longer any possible resurgence in fertility will take to restore age structure balance in the population. But it is far from certain that any such turnaround in the situation is imminent, so greatly does it depend on the position of women in society and, more generally, children's place in their scale of priorities.

Historically, women's lives were taken up with bearing and raising children; now, these activities occupy only a small part of their lives: More women work, leaving the labor force only for short periods (confinement and delivery), and have many fewer births, being more intent on pursuing their careers in historically male jobs. The world of work has not yet fully adjusted to the growing number of women, which is a competitive handicap to those trying to balance work and motherhood because job characteristics (working time and procedures) and promotion prospects are still patterned on male lifestyles. In many areas, therefore, career opportunities are dictated by the early years of working life and generally fixed around 30 years, just the age at which personal and family choices—partners and family size—are played out. Basically, women today want financial independence and a professional career and spend most of their youthful years in education and establishing a foothold in working life, which means deferring or abandoning plans to start a family. Obviously, until such time as work and fertility can be fully reconciled, women will almost always choose the former over the latter.

Overlaying this are the consequences of changing family patterns. Demographic transition evidenced a shift from the patriarchal family to the nuclear family; but far from being a foundation of permanent stability, the latter is now being called into question in turn by marriage break ups and new living arrangements. Rising divorce and separation rates are almost automatically increasing the proportion of lone, often marginalized, mothers. This severing of parental bonds has affected the postwar generations, especially the baby boomers (i.e., those who will soon be adding to the oldest age group). Rising insecurity related to the loosening of traditional ties of solidarity, places new demands on social protection, which could further undermine existing systems. Failure to address this new situation may hinder a return to demographic balance, as the fear of marriage breakdown may depress fertility. All in all, the only-child option, perhaps combined with deferred childbirth or even voluntary infertility, could well become an established societal norm with a series of repercussions on the future population dynamic.

This concern about the demographic future of the developed world may seem out of place, given the magnitude of the problems pulling in opposite directions today within many developing countries. Yet it appears likely that the globalization of demographic processes will turn it into the key issue for all humankind within the next few decades. However, this must not eclipse the fact that a significant proportion of the world's population will still have to contend with the problems of rapid population growth for some decades to come.

The completion of the demographic transition, foreshadowed and confirmed by each new United Nations (UN) population projection for the past 20 years, is naturally a great relief compared with the acute fears aroused less by the UN's late-1950s forecast of 6 billion people by 2000 and the resultant rash of far-fetched extrapolations made beyond that date. Right as it may be to condemn the overblown rhetoric of the past that sought to stigmatize rising births in the developing world as irresponsible or support the introduction of fertility regulation policies, it is equally important now to consider that although the impending end of the demographic transition is proof positive of the groundlessness of some past fears, many crucial problems remain to be solved.

With 6 billion men and women in 2000, the hardest part may seem to be over. We have gone from 2.5 to 6 billion in 50 years and have still to go from 6 to 9.5 in the next 50 years. We have therefore experienced an increase of 3.5 billion in a half-century, from a starting point of 2.5—a 140% rise—while the 3.5 billion still to come, also in a half-century, is a mere 60% increase over the current 6 billion! Granted, but two problems still remain. One is that the results to date are hardly impressive: 20% of the world's population has 80% of its income, while the overwhelming majority share the crumbs that remain. This is not a matter for pride, especially given the very unequal division of that remainder. Poor countries increasingly have to be divided between genuinely developing countries and very poor countries whose extremely fragile economies are on the brink of collapse.

Above all, however, a large share of the 3.5 billion people added in the last 50 years accreted directly to developed countries with growing populations (especially North America and the former Union of Soviet Socialist Republics [USSR]) while the bulk of that in the south was added by the most dynamic countries or regions (China, Southeast Asia, Latin America). By contrast, the next 3.5 billion will be almost entirely added to the world's poorest countries or areas, especially in sub-Saharan Africa and some South Asian countries. Setting this further increase against the current total population of the regions most affected (under 2 billion), we get a real growth figure of nearly 200%. However, not only are these countries the world's poorest, but unlike most of Asia or Latin America whose highest population growth came during the "30 boom years," today's poorest countries will incur theirs in adverse international economic conditions (Vallin, 2000).

Arguably, there is every reason for consigning to history what in fact we should never have feared, but there is now all the more reason to look seriously at what, all rhetoric aside, we have consistently put off to later: the economic and social development of the poorest regions. This remains a live and very urgent issue, like finding environmentally sound development models that respect the broad balance of nature on the planet.

VI. FUTURE POPULATION DYNAMICS

It is a racing certainty that once this exceptional growth period has peaked, all the world's populations will more or less attain a mortality—fertility equilibrium in the near or relatively near future. However, there are no guarantees that it will remain stable. What is most likely is that the end of the great historical process dubbed "demographic transition" will also see the end of the like-named paradigm.

Barely had the UN ventured to produce its fine simulation of a general stabilization of the world population based on the transition theory in the early 1980s than the fault lines began to show everywhere. Less because of its failure to predict the acquired immunodeficiency syndrome (AIDS) epidemic in Africa or the health crisis in Eastern Europe (which, however appalling, are finally just adverse developments that cast no doubt on the fundamentals of the model) than because of the growing body of evidence that "the end of the transition" will be anything but that expected. The postwar baby boom experience should have sounded the alarm bells, but the fact is that World War II upset so many apple carts that it might be reasonably thought to be only an interlude in the unfurling of an inevitable historical process. And that is how it was seen.

But, how could it be thought that declining mortality and fertility, the period of exceptional growth due to the time lag between the two, and the resulting upheaval in age structures, would end up in a period of general stability? How could it be thought that after the storm would come the eternal, untroubled calm on nothing more than the belief that life expectancy at birth would never extend beyond 85 and that fertility would inevitably level off at 2.1 children per woman? There was nothing, absolutely nothing, to suggest that it would be this way. To the contrary, all the signs today are that things could go very differently. Sadly, there is no new paradigm, model, or theory with which to accommodate not the end of the demographic transition, but its expected consequences. All that can be done when imagining the long-term future, therefore, is to devise possible alternative scenarios for fertility and mortality and their expected consequences for the total population and age structures. Admittedly, it can be done on the basis of currently observable facts, but the future import of those we cannot tell.

As to fertility, first, two facts give pause for thought. First, in a number of northern countries, the total fertility rate has been significantly below the replacement level of 2.1 children per woman for the past 20 years. In some, it has even been far below: 1.3 in Germany, Italy, and Spain, for example, and even 0.8 in Northern Italy! Second, mean age at childbirth is rising significantly. These two facts may not be unrelated. It could readily be assumed that a late first birth would reduce period fertility to very low levels simply as the combined result of very low fertility among women who completed their fertility when younger and the

continuing very low fertility among younger women who are putting off motherhood. Overall lifetime fertility aspirations may be unchanged, but, in these conditions, period fertility could actually fall to very low levels at least for a certain time. Obviously, it may equally well be that what has really changed is desired family size.

On the basis of these different possible interpretations of the changes in progress, one chapter of this treatise will seek to explore various fertility trend scenarios that combine assumptions about level (from a return to replacement level to the only-child model) and timing (early or late, with one or two key family formation periods).

Still on the basis of current facts, questions arise about the lasting quality of a parameter that demographers have in the past always taken as stable—the sex ratio at birth. It is a universal fact that until very recently the number of male births was always slightly above female births (105 males to 100 females), with excess male mortality redressing the balance at childbearing age. Now, in some societies where male preference is particularly strong, this successful balance is being seriously undermined by antenatal gender diagnosis and the possibility of selective abortion. In some parts of India and China, the sex ratio at birth has now risen to 120, 150, and above. What would be the result of a long-term spread of such behavior?

But fertility is not the only question mark for the future. Contrary to expectations, the future of average duration of life is little more certain than that of fertility. Disregard the possibility of humankind being simply wiped out by a nuclear war, or an epidemic even worse than AIDS is proving for Africa. Leave to the gloom merchants the idea that life expectancy could fall on a long-term basis worldwide as it recently has in the Eastern European countries. The game still remains wide open. There are, in fact, two theories today setting biologists and demographers at odds with one another.

The first says that we are fast approaching the absolute limit of human longevity. Having raised life expectancy from 25 in the 18th century to 80 years now, all we have done is to bring the average (life expectancy) closer to the maximum possible life span (longevity). Only the former is susceptible to change, while the latter is irreversibly fixed by the initial life potential written in our genes. It is clear that the closer one gets to the maximum, the harder it is to raise the average. Furthermore, because of the variations in individual gene pools, the upper limit itself varies widely between individuals, and the absolute record recently set by Jeanne Calment, who died in 1997 slightly older than 122 years, is just that—a record (i.e., a score that only a tiny number of individuals will ever be able to match). This line of reasoning has led biologists like James Fries (1982) and demographers like Jay Olshanski (1990) to conclude that it is virtually impossible for life expectancy to exceed 85 years. This, indeed, is the underlying assumption of the most recent UN projections.

There is, however, another theory that human longevity is not immutable. First, we have no evidence that it has not increased in the past. Methuselah aside, anecdotal evidence of extreme longevity is not uncommon in historical records, but singularly lacking in hard proof (Vaupel and Jeune, 1994). No proof has ever been produced of any man or woman before Jeanne Calment attaining the age of 120 (Allard *et al*., 1994). However, there is a well-established tendency in almost all societies to exaggerate the age of very old people. By contrast, there is circumstantial evidence that human longevity may have increased in recent decades (Robine *et al*., 1997). The highest age at death has risen each year in the most advanced countries over the past 40 years (Wilmoth and Lundström, 1996). Also, since the 1970s, mortality among the oldest age groups (over 75 years), which had been relatively stable suddenly, began to recede (Kannisto, 1994, 1996; Meslé and Vallin, 1998). Finally, some biologists, like Roy Walford (1984), for example, believe that we are on the threshold of effectively delaying the human aging process. If so, anything becomes possible.

Without going as far as André Klarsfeld and Frédéric Revah (1999) with their suggestion that immortality does not exist, not because of biologic imperatives, as had always been thought in the past, but simply because serving no biologic purpose, it did not evolve, should we not, for example, admit the plausibility of Roy Walford's proposition that life expectancies of up to 150 years should not be beyond imagining in the 21st century? What effect would that have on populations?

All these scenarios would obviously have very different consequences in terms of total populations and demographic structures. The world population, for example, could just as easily continue to grow rapidly after 2050 or collapse to pre-Neolithic levels with the risk of being wiped out altogether. Alternatively, "reasonable" aging leading, for example, to 30% of the population aged over 60 is just as likely as a radical upheaval in age—sex structures going far beyond even the most radical predictions so far: Life expectancy of 150 years and a single-child family trend could, for example, produce a population with only 2% of "young people" (younger than 20 years) and 7% of "adults" (aged 20 to 60 years), but 91% of people older than 60 years and 74% older than 100 years! Obviously,

the descriptions young person, adult, and old person could not then be applied to the same age groups as today. Regardless, given the difficulties we now have contemplating the prospect of living tomorrow (in 2050) in a society where at least 30% and perhaps even 40% of the population will be older than 60 years, how can we envisage a world where three fourths of the people will be centenarians? It is easy for demographers to make population forecasts, but it is much harder to envision the kind of society that they would produce. Sociologists, psychologists, economists, and political scientists would also have to think hard! Much will depend on their respective abilities to communicate and create synergies of knowledge. In any event, the size of the challenges, the complexity of development factors, and the still largely uncharted possible consequences require a new demography with a broad cultural focus capable of addressing issues holistically. The next stage will probably see new developments increasingly tracked through in-depth surveys that pave the way for research into the linkages between socioeconomic and environmental changes and the demographic—and even biologic—components of the population and the development of a framework of theories and assumptions capable of connecting all the components of demographic thought and experience with those of life as it is lived in an overall approach. For that to happen, demographers will obviously have to be more skilled in combining macroanalysis with microanalysis, moving from the forensic analysis of types of behavior and their determinants to interpreting them at the holistic level of the complex systems in which we live.

In relation to the state of the art in methods and knowledge, this view of demography lies more in the realms of science fiction than today's realities. At the very outside, it may perhaps be incipient. This book, therefore, does not seek to offer its readers what does not yet exist. Its aim is less lofty: to report on what does exist, pointing up the consistencies but also the emerging inconsistencies that may foreshadow the future shape of our discipline.

GENERAL LAYOUT

This treatise on demography comprises four volumes. This volume, the *first* in the series, falls into two sections. Section I discusses population dynamics and focuses on the essence of demography: the analysis of the components of population change related to changes in total population and age–sex structure. It falls into five parts, themselves directed by the overall approach taken in this treatise progressing from analysis to synthesis. Part one covers population growth, with an initial overall view of the principles of population dynamics. Part two is given over to the analysis of the three specific components of population change (fertility, mortality, migration) in the context of the life experiences of cohorts. In part three, the measurements made are reconstituted as period indicators to track demographic trends. This paves the way for an initial synthesis followed, in part four, by the construction of population models. Part five looks at ways in which to take account of the dependency between demographic phenomena and of population heterogeneity.

The following chapters analyse the factors of each of the three building blocks of population change: fertility, mortality, and migration. There are separate parts of each component, where the different types of factors (biological, socioeconomic, cultural) and levels of explanation (baseline variables and intermediate variables, theories, frameworks, and explanations) are addressed. The determinants of fertility are covered in Section II of Volume I, while those of mortality and migration are successively discussed in the two sections of Volume II.

The first section of Volume III addresses the history and consequences of demographic change, i.e., the history and geography of human settlement but also population forecasts. Section II considers the consequences of demographic changes in the biological and health fields, in the socioeconomic and cultural ones, on development, and on the environment.

The fourth and final volume covers, in Section I, population theories and doctrines and population policies. Section II falls into three parts and considers observation systems, auxiliary methods in demography, and the history and teaching of demography.

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