Retirement in Dual-Career Families: A Structural Model

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A structural econometric model of retirement of dual-career couples is specified and estimated with panel data from the National Longitudinal Survey of Mature Women. A coincidence of spouses retiring together, despite the younger ages of wives, suggests explicit efforts at coordination. The estimates suggest that one reason is a correlation of tastes for leisure. More important, each spouse, and perhaps husbands in particular, values retirement more once their spouse has retired. The opportunity set accounts for peaks in the retirement hazards of each spouse individually but not for peaks in the simultaneous retirement of both spouses.

I. Introduction

This paper specifies and estimates a structural model of the retirement decisions of husbands and wives. The feature of the data that is of central interest to us is the tendency of husbands and wives to retire together. An econometric approach is developed for estimating preferences of both

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spouses jointly and is implemented using data from the National Longitudinal Survey of Mature Women (NLS), a survey that provides the most recent data available for a joint retirement study. Alternative specifications of joint decision making are tested, and the importance of various sources of interdependence in decision making are investigated.

The present analysis joins together two branches of the retirement literature. In one, structural retirement models are estimated from data on individuals, usually men, while ignoring the retirement decisions and retirement status of their spouse.[1] In the other, retirement decisions of husbands and wives, and the tendency of their retirement dates to cluster, are analyzed in the context of a reduced form model.[2]

To join these strands of the literature, this paper extends structural retirement modeling to incorporate the joint determination of retirement decisions of husbands and wives. In particular, the model is designed to recognize a number of potential sources of interdependence in the retirement decisions of both spouses. In the opportunity set, jobs may be selected with peaks in pension accrual profiles that encourage joint retirement. On the preference side, each spouse's utility may depend on the retirement status of the other spouse, or the preferences of each spouse may be correlated.

In a world where both the husband and wife are more and more likely to be working until the retirement years, this kind of a model will be increasingly necessary to assess how pension, social security, and other retirement related policies affect retirement outcomes, including the question of whether policy measures that affect the retirement decision of one family member can indirectly influence the retirement of the remaining spouse.

A second purpose of this paper is to provide a structural retirement analysis using data for a nationally representative panel study that includes respondents who are 2 decades younger than the respondents who were included in structural retirement analyses conducted to date with nationally representative data.[3] The women in the National Longitudinal

[1] See, e.g., Burtless and Moffitt (1984); Fields and Mitchell (1984); Gustman and Steinmeier (1986*a*, 1986*b*); Lumsdaine, Stock, and Wise (1990, 1992, 1994, 1996); Stock and Wise (1990*a*, 1990*b*); and Berkovec and Stern (1991). For an analogous structural model of retirement fit to data for married women, see Pozzebon and Mitchell (1989).

[2] Estimates of systems of reduced-form retirement equations, such as those in Clark and Johnson (1980) and Hurd (1990), suggest the importance of the spouse's retirement status and of the joint determination of the retirement decisions of husbands and wives.

[3] Most structural analyses that are based on nationally representative panel data sets, even recently completed studies, have made use of the Retirement History Study (RHS), a longitudinal survey with cohorts born between 1906 and 1911. However, the RHS has only limited information on the labor market activities of wives, and in any case the RHS has become outdated as the participation patterns of wives have changed drastically over the past 2 decades.

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Survey of Mature Women were born between 1923 and 1937. In 1989, they were 52–66 years old, about as young as feasible for a retirement study.

The paper also addresses a number of econometric and behavioral issues. One issue is that some workers still have not retired at the end of the survey. In a panel of older workers such as the RHS, almost all couples have retired by the final survey year, so there is more or less complete information on retirement dates and on the characteristics of all individuals included in the sample. In the National Longitudinal Survey of Mature Women, many of the couples are too young for both to have retired. Accordingly, in the process of the analysis, we deal explicitly with censoring of continuing employment spells.

In specifying and estimating the retirement model for couples, we are primarily interested in assessing the causes of joint retirement. Are the retirement decisions of the two spouses interdependent, so that the wife waits to retire until the husband retires, or vice versa? Are their preferences correlated, perhaps because individuals who want to retire early (or late) are attracted to one another? Or is it possible that spouses are induced to retire at the same time by such factors as pensions that happen to offer retirement in the same year? We also address the following questions: How does the retirement behavior of each spouse compare to that of the other? What are the effects on model parameters of entirely ignoring interactions in preferences? What are the effects of treating each spouse's retirement decision as exogenous in estimating the retirement behavior of the other?

The next section will present evidence from the NLS that in fact, in the raw data, there is a noticeable tendency among couples who have both retired to retire together. A labor supply model of dual-career families is developed in Section III. Section IV details the data preparation and presents alternative estimates of the model. Section V presents some simulations based on the estimated model, concentrating mainly on the extent to which the husband's and wife's retirement decisions are coordinated. A final section presents some concluding thoughts.

II. Evidence of Joint Retirement

There is not much point in investigating the cause of couples tending to retire together if the phenomenon is not evident empirically. The purpose of this section is to verify that the phenomenon does exist in the NLS older women's data and to document the sample that is used in this section and in the remainder of the project.

The sample we use is from the National Longitudinal Survey of Mature Women. This survey contains 2,270 women who were married at the beginning of the survey and who participated in the surveys through

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1989.[4] Of these, 436 are dropped because the wife became widowed, 314 are dropped because of divorce or separation, 926 are dropped because at least one of the partners (usually the woman) was not a career worker, and 30 are dropped because of lack of wage data.[5] These criteria leave a sample of 564 couples.

The sample exclusions reflect two limitations on the scope of this paper. First, the model does not allow for uncertainty, particularly uncertainty related to marital stability. This limitation is perhaps less important than would be true for younger cohorts since only 14% of the couples in the potential sample divorced over a 22-year period. In any case, estimating a family labor supply model with uncertainty is probably beyond our present computational abilities. The second limitation is that the model does not deal with the decision, particularly by the wife, to engage in a meaningful career, but only with the decision to retire from a career that has previously been entered. Most of the women eliminated because they were not "career" workers either did not work in any of the surveys or had only very sporadic work. It is difficult to regard such women as having a "career" from which they could "retire." We feel uncomfortable treating the decision of whether to engage in career work merely as another aspect of the decision of when to retire, and instead we prefer a different model for this decision and limit the present analysis to retirement per se. A consequence of this decision is that we are analyzing a sample of families that may not be completely representative of the general population of families.

Figure 1 shows the distribution of relative retirement ages of wives and husbands for those couples who had retired by 1989.[6] In this study

[4] Since the initial age of respondents was 30–44 in 1967, women who dropped out in the early years of the survey did so before reaching retirement age, and hence these women would not shed much light on a retirement analysis in any case.

[5] "Career" workers refer to those with substantial full-time work experience (at least three consecutive surveys of work after age 40 and at least one-half of the surveys before the last survey with full-time work for women, or at least two-thirds of the surveys before the last survey with full-time work for men) and at least one survey of full-time work after age 50. Full-time work means at least 25 hours of work per week for women or at least 1,250 hours per year for men, for whom usual weekly hours are not always available. Using a 35-hour-per-week or 1,500 hour-per-year definition results in slightly higher joint retirement, but at a cost of about 20% of the sample.

[6] Those with a recorded retirement age are a minority of the sample since most of the couples with dual careers had one or both partners still working in 1989. A larger proportion of early joint retirees is included among the couples in figure 1 than is observed for the whole sample. Accordingly, the gap in retirement ages is probably understated in that figure. Also, those individuals who have a stronger preference for leisure are disproportionately more likely to be reported among those couples who have both retired. The later estimation takes account of this censoring problem.

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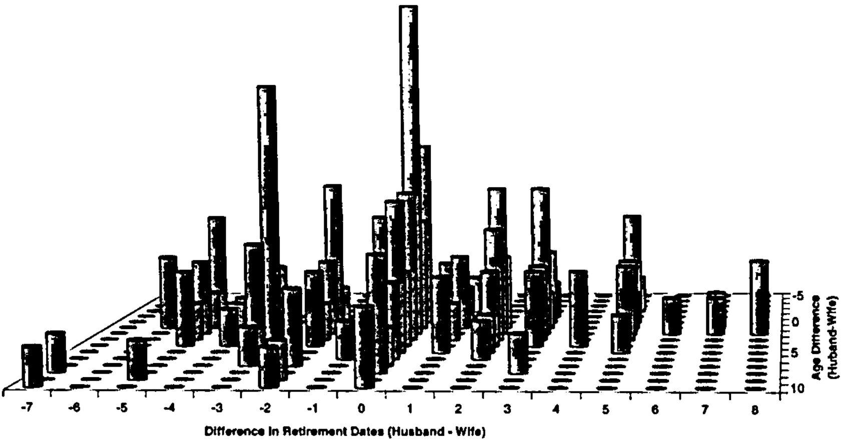

FIG. 1.—Distributions of retirement dates for couples with both husband and wife retired

retirement is considered to have occurred at the survey immediately following the last observation of full-time work.[7] Across the bottom of the figure are the differences in retirement dates between the husband and wife. A value of 4, for instance, indicates that the husband retired 4 years after the wife. Down the right side are the age differences between the husbands and wives. A value of 5 would indicate that the husband is 5 years older than the wife. Most of the observations are in the part of the figure below the line corresponding to an age difference of zero, indicating that in most cases the husbands are somewhat older than the wives.

One might expect a negative relationship in these data because, if the husband is considerably older than the wife, it is not unreasonable to expect him to retire earlier relative to the wife's retirement. The relationship is in fact negative, but the correlation of these 138 observations is rather low at −0.21. The interesting feature of this figure is the distinct concentration of retirement when the husband and wife retire simultaneously. Given the way the retirement dates were constructed, what this really means is a concentration of couples reporting the last date of full-time work in the same survey year. Because the surveys were frequently conducted at 2-year intervals, the actual retirements could have taken place a year apart one way or the other. Even so, the concentration of retirements at dates so close to one another suggests that couples do tend to retire at about the same time and that this phenomenon is evident in the data to be used in this study.

[7] In the NLS, labor force status for wives is ascertained by a series of Current Population Survey–like questions, and that of husbands by questions relating to the number of weeks worked and the usual hours per week.

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Table 1
Retirement Percentages for Husbands

	Type of Spouse	
Age	Working	Nonworking
55	7.2	8.1
56	11.4	11.0
57	15.3	13.1
58	20.0	18.5
59	24.9	23.4
60	30.8	29.4
61	39.3	36.8
62	49.1	46.6
63	59.1	54.8
64	70.6	59.7
65	76.8	70.2
66	80.6	73.8
67	83.5	74.2

NOTE.—Retirement dates are calculated as the year immediately following the last observation of full-time work.

Although the main focus of this paper is joint retirement, it is interesting to compare the retirement patterns of husbands with and without career wives. The results reported in table 1 indicate that husbands with career wives are moderately more likely to be retired, especially above age 60. This is not entirely surprising; the lifetime earnings of the working wives reduce the pressure on the husbands to continue working to supply the household with income. The other interesting feature of the table is that the husbands with noncareer wives are more likely to concentrate retirement at age 65. This suggests that they respond to social security and pension incentives to retire at that age more than do husbands with career wives, who may have other factors that come into play in the retirement decision.

III. A Model of Labor Supply and Retirement in Dual-Career Families

In this section we will develop a model of labor supply and retirement in dual-career families and detail an approach to estimating the model empirically. Before developing a model to bridge the structural retirement literature and studies of family retirement, it is appropriate to comment on the state of the structural retirement literature and where the approach taken in this paper fits into that literature.

A. Relation of the Present Analysis to the Retirement Literature

There are a number of elements that should be included in a fully dynamic specification of a structural model of retirement. Lazear and

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Moore (1988), Lumsdaine et al. (1990, 1992, 1994), and Stock and Wise (1990*a*, 1990*b*), have emphasized the importance of including the option value of the pension in the opportunity set. Gustman and Steinmeier (1983, 1984, 1985*a*, 1986*a*, 1986*b*) have emphasized the importance of modeling hours constraints on the main job and the availability of partial retirement only at a lower wage. Rust (1990) and Berkovec and Stern (1991) have developed stochastic dynamic models, which among other things allow reverse flows to arise even without observed causes. There is no single model that incorporates all of these features. Analyses of retirement that take account of the pension and the option value of the pension focus on the decision to leave the main job but do not model either the decision to engage in part-time work or the dynamic of flows among retirement states. Models that take account of flows among retirement states, including reverse flows, ignore the existence of the pension, let alone the option value of the pension.[8]

The model used in the present study both extends a structural analysis to incorporate the retirement decisions of households with two full-time earners and also specifies and estimates the model to incorporate the incentives from the option value of the pension. However, like the analyses of individuals considered in isolation, it does not take account of all the potential elements that should enter a complete retirement analysis. More specifically, the model focuses only on the decision to reduce work effort below full time and does not analyze the decision to retire partially. Nor does it analyze reverse flows among retirement states. Accordingly, the work presented in this paper falls short of an ideal structural retirement analysis in a family setting. This ideal has yet to be reached in any structural retirement analysis, even analyses that limit themselves to the retirement behavior of individuals considered in isolation.

B. Model Specification and Estimation Strategy

The model we estimate is essentially a noncooperative bargaining model. Because the central concern of the model is the behavior of each of two spouses who have independent earnings capacity, a bargaining model seems preferable to a model with a single aggregated utility function for the household that is derived via some consensus mechanism within the family.[9] Nevertheless, because there is a collective good (con-

[8] See, e.g., Rust (1990) and Berkovic and Stern (1991). Studies that use pension information are Fields and Mitchell (1984), Lumsdaine et al. (1990, 1992, 1994), and Stock and Wise (1990*a*, 1990*b*), but these studies include only a few firms and do not have very much information about the individuals covered by the pension.

[9] For a discussion of evidence that consumption patterns depend on which family member controls the income source, a finding that is inconsistent with a simple model of common preferences, see Lundberg and Pollak (1996). Becker

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sumption), we cannot treat the decision making by each spouse as totally independent. The model also includes elements of altruism or joint production in that the utility of each spouse is affected by the leisure of the other spouse. In addition, the model allows cooperation when interdependence in leisure raises the utility of joint retirement. Although eclectic, this specification of the model can thus be defended as incorporating some of the best features of the leading approaches that have been taken to analyzing family labor supply.

The model begins with fairly standard utility functions for the two spouses, each of which depend on lifetime consumption and labor supply. For the wife, utility is given by

$$U_w = \sum_{t=0}^{T} \left[\frac{1}{\alpha} C_t^{\alpha} + e^{X_t^w \beta_w + \gamma_w L_t^h + \varepsilon_w} L_t^w \right].$$

In this utility function, C_t is family consumption and L_t^w is the leisure of the wife, which takes on a value of zero if the wife is working full-time at time t and a value of one if she is retired.[10] The symbol t is time since household formation, with T being the length of time that the members of the household are expected to be alive.[11] Primarily to keep the model simple enough to estimate, part-time work is ignored and retirement is considered to be an absorbing state; once retired, the wife cannot return to work. Variables and coefficients associated with the wife are indicated in this expression by a w; h's indicate variables and coefficients associated with the husband. The term $e^{X_t^w \beta_w + \gamma_w L_t^h + \varepsilon_w}$ determines the relative value of retirement to the wife. The vector X_t^w is a vector of variables including a constant term, age, and health status, and L_t^h is the retirement status of the husband (either zero or one). The variable ε_w is an individual fixed effect that determines the relative value of retirement for different women. The higher the value of ε_w, the more the wife values retirement, and the sooner she will retire, all other things being constant. As the wife becomes older,

([1981]1991) and Chiappori (1992) debate the virtues of a model with a dominant altruist, while McElroy and Horney (1981), Manser and Brown (1980), and Lundberg and Pollak (1996) discuss models with threat points. For a related discussion of noncooperative bargaining models of the family, see Lundberg and Pollak (1993).

[10] A time preference term of the form ϕ^t could also be included in the utility function. However, empirically it is not separately identified without using consumption or asset data, which are notoriously noisy.

[11] In the empirical work, the planning horizon runs from the year the wife turns 25 until the year she turns 85.

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$e^{X_t^w\beta_w+\gamma_w L_t^h+\varepsilon_w}$ increases because of the general effects of age and possibly a worsening health status in $X_t^w\beta_w$. Eventually the value of retirement outweighs the value of the wages from working, and the wife retires.

There are three ways in which this utility function can be construed to be part of a family labor supply model. First, the consumption in this function is, not the consumption from the wife's own earnings, but the family consumption financed by the earnings of both husband and wife. Second, the retirement status of the husband, L_t^h, affects the value of retirement for the wife. If γ_w is positive, the wife will value her own retirement more highly if the husband is also retired. Finally, the value of ε_w may be correlated with the corresponding value ε_h for the husband. This is the means by which the leisure preferences of the husband and wife may be correlated.[12]

The utility function for the husband is symmetric:

$$U_h = \sum_{t=0}^{T} \left[\frac{1}{\alpha} C_t^\alpha + e^{X_t^h\beta_h+\gamma_h L_t^w+\varepsilon_h} L_t^h\right].$$

The terms in this function are analogous to the terms in the wife's function. In particular, the term L_t^w in the coefficient of the leisure term allows the value of retirement of the husband to depend on the wife's retirement status. Also, note that the family consumption term C_t is the same term as in the wife's utility function and that the parameter α governing the utility of consumption is the same in both functions.

Both husband and wife maximize their respective utility functions subject to the constraint that lifetime family consumption cannot exceed family income:

$$\sum_{t=0}^{T} d^t C_t = Y$$

$$= \sum_{t=0}^{T} d^t(1 - L_t^w)W_t^w + \sum_{t=0}^{T} d^t(1 - L_t^h)W_t^h.$$

In this budget constraint, both consumption and wages are expressed in real terms, and d is the real discount rate. If the husband and/or the wife are working at time t, W_t^w and W_t^h are the wife's and husband's compen-

[12] Conformity in the labor supply of spouses is a very general phenomenon that extends beyond retirement. See, e.g., Giannelli and Micklewright (1995), who report conformity in husband and wife participation.

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sation amounts, respectively. In addition to wages, compensation includes accruals to pensions and social security, which are the increases in the expected discounted benefits arising from working in the job for another year. The model does not allow for uncertainty, an omission that is forced on us by computational considerations.[13]

The decision making within the family is fairly simple. First, note that given the common consumption parameter α, both spouses can agree on how to spend a given amount of lifetime family income. In choosing the labor supply, we assume that each spouse knows the leisure preferences of the other. Each spouse then chooses that labor supply to maximize his or her own utility function, given the labor supply that the other spouse will choose as a result. A solution to the problem will be a Nash equilibrium, with a caveat. Since each spouse's labor supply enters the utility function of the other spouse, there is the possibility of two or more Nash equilibria. If one of the equilibria is advantageous to both spouses, we assume that the couple chooses it. If one is advantageous to one spouse and the other is advantageous to the second spouse, we assume that the spouse who retires first chooses the retirement date that is advantageous to that spouse, taking into account the retirement date that the second spouse will subsequently choose. In essence, the spouse who retires first can commit the couple to the Nash equilibrium that he or she prefers. Since both spouses know each others' preferences from the start, the consumption and labor supply decisions can be planned at the beginning of the life cycle, and since there is no uncertainty or reason for either spouse to change plans midway through the life cycle, there will never be any reason to deviate from the initial plan.[14]

We begin to characterize the solution to the model by analyzing consumption first. Given a lifetime family income amount Y and the common consumption parameter α, both husband and wife can agree on the time path of consumption. For both spouses, the objective is to choose the time path of consumption so as to solve

[13] Economists are just now able to estimate models of consumption and retirement for single individuals, and even then the models often lack important features, such as ignoring workers with pensions or ignoring the pensions themselves. See, e.g., the recent work by Rust and Phelan (1997).

[14] Some forms of altruism can also be accommodated within this model. For instance, if the husband values the wife's leisure time, and the wife wants to take this into account in choosing her retirement date, the values of γ_w can be interpreted as including both her and her husband's value of her leisure. However, if the husband values the wife's leisure time only if he is retired himself, the wife cannot take this into account in the present model, and a more complicated model is required.

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$$\max U_c = \sum_{t=0}^{T} \frac{1}{\alpha} C_t^{\alpha}$$

subject to

$$Y = \sum_{t=0}^{T} d^t C_t.$$

Setting up the Lagrangian and differentiating with respect to C_t yields

$$C_t^{\alpha-1} - d^t\lambda = 0,$$

which can be solved for C_t as follows:

$$C_t = (\lambda d^t)^{1/(\alpha-1)}. \tag{1}$$

Multiplying by the discount factor and summing over the time periods yields

$$Y = \sum_{t=0}^{T} d^t C_t$$

$$= \lambda^{1/(\alpha-1)} \sum_{t=0}^{T} d^{t(\alpha/(\alpha-1))}.$$

This equation can be solved for lambda and substituted into equation (1) to yield an expression for consumption:

$$C_t = \left(\frac{Y}{\kappa}\right) d^{t(\alpha/(\alpha-1))}$$

where

$$\kappa = \sum_{t=0}^{T} d^{t(\alpha/(\alpha-1))}. \tag{2}$$

Substituting this optimal consumption rule into the utility function yields

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$$U_c(Y) = \sum_{t=0}^{T} \frac{1}{\alpha} C_t^\alpha$$

$$= (1/\alpha\kappa^{\alpha-1})Y^\alpha.$$

Now let us turn our attention to the retirement decision. Recall that in this model retirement is assumed to be permanent; once retired, an individual remains retired. Suppose that the husband were to retire at age R_h and contribute a corresponding amount of lifetime earnings to the family budget constraint. The wife will be indifferent between working and retiring at year t if the utility value of leisure at time t just matches the utility value of the additional income from working during year t. Let $Y^w_{t-1|R_h}$ denote total discounted family income if the wife retires at the beginning of year t (and the husband retires at age R_h), and let $Y^w_{t|R_h}$ denote the income if she works in year t and retires at the beginning of year $t + 1$. Note that $Y^w_{t|R_h} - Y^w_{t-1|R_h} = d^t W^w_t$. The condition of indifference will be

$$e^{X^w_t\beta_w+\gamma_w L^h_t+\varepsilon_w} = U_c(Y^w_{t|R_h}) - U_c(Y^w_{t-1|R_h})$$

$$= (1/\alpha\kappa^{\alpha-1})[(Y^w_{t|R_h})^\alpha - (Y^w_{t-1|R_h})^\alpha]$$

$$= (1/\alpha\kappa^{\alpha-1})\alpha\tilde{Y}^w_{t|R_h})^{\alpha-1}(Y^w_{t|R_h} - Y^w_{t-1|R_h})$$

$$= (\tilde{Y}^w_{t|R_h}/\kappa)^{\alpha-1}d^t W^w_t,$$

where $\tilde{Y}^w_{t|R_h}$ is between $Y^w_{t-1|R_h}$ and $Y^w_{t|R_h}$ by the mean value theorem.[15] Note that this last term simply states that the value of leisure equals the discounted wage times the marginal utility of discounted income, evaluated at an appropriate value of Y.

Let ε^{*w}_t be the value of ε_w that just makes the wife indifferent between working and retiring at time t. Taking the logs of both sides of the above relationship and rearranging yields

$$\varepsilon^{*w}_t = \log(d^t W^w_t) + (\alpha - 1)\log(\tilde{Y}^w_{t|R_h}/\kappa) - X^w_t\beta_w - \gamma_w L^h_t. \qquad (3)$$

Let

[15] A sufficient condition for this to be a (relative) utility maximum is that the growth rate of discounted wages be less than the growth rate of the value of leisure. Since the wage equations imply relative flat wages above 50 years of age, this condition is satisfied.

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$$L_t^{*w} = \varepsilon_w - \varepsilon_t^{*w}$$

be a latent variable whose value is positive if the wife finds it advantageous to be retired. Substituting from (3) yields

$$L_t^{*w} = X_t^w \beta_w + \gamma_w L_t^h + \varepsilon_w - \log(d^t W_t^w) - (\alpha - 1)\log(\tilde{Y}_{t|R_h}^w/\kappa), \quad (4)$$

where L_t^h is the realized value of the corresponding latent variable for the husband. That is, $L_t^h = 1$ if the husband is retired, and $L_t^h = 0$ if the husband is still working. The equation for L_t^{*h} is symmetric:

$$L_t^{*h} = X_t^h \beta^h + \gamma_h L_t^w + \varepsilon_h - \log(d^t W_t^h) - (\alpha - 1)\log(\tilde{Y}_{t|R_w}^h/\kappa). \quad (5)$$

Equations (4) and (5) are similar to what Schmidt (1981) terms a simultaneous probit model with truncated endogenous variables. He points out that one difficulty with a model of this sort is that, for given values of ε_w and ε_h, there may be either no solutions or multiple solutions for L_t^w and L_t^h. In the case at hand, if γ_w and γ_h are both sufficiently greater than zero (implying that each spouse enjoys retirement more if the other spouse is also retired), there will be multiple solutions of the above equations for some values of ε_w and ε_h. Recall, however, that equations (4) and (5) do not *define* the solution, but are merely *necessary* conditions for a solution to the underlying utility problem. If there is more than one solution for equations (4) and (5) for a given pair of values for ε_w and ε_h, the dominant solution is the solution for the underlying behavioral problem. In the underlying problem, as discussed before, if one solution is better for both spouses, that is the solution the spouses will choose. If one spouse prefers one solution and the other spouse prefers another, the spouse retiring first commits the couple to the solution of his or her choice.

Unfortunately, the current problem is considerably worse since $\tilde{Y}_{t|R_h}^w$ and $\tilde{Y}_{t|R_w}^h$ are both implicitly functions of L_t^w and L_t^h not only for the current period but for all periods. This means that the problem is not simply a bivariate problem but a probit problem with $2(T + 1)$ equations. There are two important questions associated with this problem. First, for given values of ε_w and ε_h, is it always true that there will be a solution to these probit equations? And second, for those sets of values for ε_w and ε_h that have more than one solution to the probit equations, will the above behavioral model be sufficient to choose among the solutions?

An algebraic analysis of these questions is difficult, so we approach them graphically instead. To do this, consider a figure with ε_w on one axis and ε_h on the other axis, as in figure 2. Each point in this figure represents

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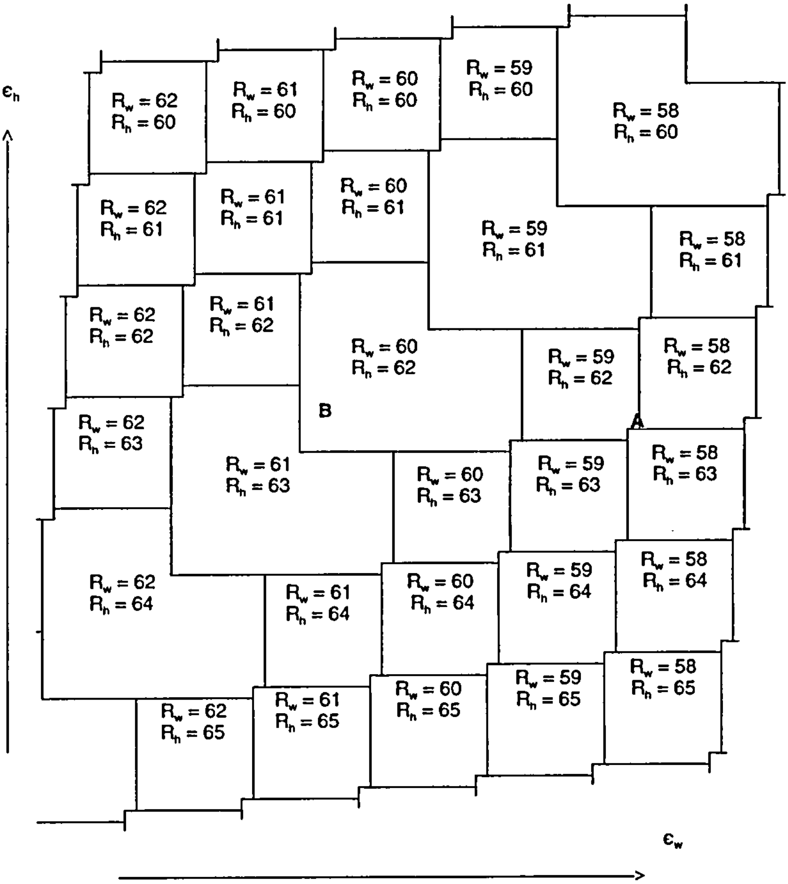

FIG. 2.—Relationship between retirement preferences and retirement outcomes

a possible combination of ε_w and ε_h. Given the exogenous variables in the model (i.e., the compensation streams and the values for the X's), and given a particular combination of the leisure preferences ε_w and ε_h, the two spouses will choose their retirement dates. Note that the retirement decisions determine lifetime household income, which in turn determines consumption through equation (1).

We can group areas of ε_w on one axis and ε_h which yield the same retirement date into cells labeled by the associated retirement dates. For instance, the cell labeled as $R_w = 59$, $R_h = 63$ contains combinations of ε_w and ε_h for which the wife would retire at age 59 and the husband at age 63. To construct a particular cell in this figure, we first ask what combinations of ε_w and ε_h would produce a Nash equilibrium for the retirement ages corresponding to that cell. We see that these cells completely cover

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the figure. That is, every combination of ε_w and ε_h belongs to at least one Nash equilibrium. In some areas of the figure, however, two Nash equilibria overlap. In these cases, one of the Nash equilibria, known as a subgame-perfect solution, prevails.

Let us start by specifying the area that represents the Nash equilibrium for $R_w = 59$ and $R_h = 63$. This means that the wife is working at age 58 but retired at age 59 and beyond and that the husband is working at age 62 but retired at age 63 and beyond. For shorthand, we will refer to this area as the [59, 63] area. The exact location of this cell depends on the exogenous variables (the compensation streams and the X's) for a particular couple, and so there will be a slightly different figure for each observation. For the couple illustrated, we will assume that the husband is 2 years older than the wife.

A Nash equilibrium is one in which each spouse makes the choice conditional on the choice of the other spouse. Consider the situation of the wife, given that the husband is retiring at age 63. Equation (3), evaluated at time a, which corresponds to age 58 for the wife, yields a value of ε_w that just makes the wife indifferent between working and retiring at age 58:

$$\varepsilon_a^{*w} = \log(d^a W_a^w) + (\alpha - 1)\log(\tilde{Y}^w_{a|R_h}/\kappa) - X_a^w \beta_w.$$

Note that the term involving $\gamma_w L_a^h$ has been omitted from this expression since the husband will still be working when the wife is 58. If the actual value of ε_w is greater than ε_a^{*w}, the wife would choose to be retired at age 58. The wife will be working at age 58 only if the actual value of ε_w is less than ε_a^{*w}, that is, if the actual value of ε_w is less than the right-hand side of the above equation. Similarly, equation (3), evaluated at time b, which corresponds to age 59 for the wife, yields a value of ε_w, which just makes the wife indifferent between working and retiring at age 59:

$$\varepsilon_b^{*w} = \log(d^b W_b^w) + (\alpha - 1)\log(\tilde{Y}^w_{b|R_h}/\kappa) - X_b^w \beta_w.$$

The wife will be retired at age 59 only if the actual value of ε_w is greater than the right-hand side of this equation.

Putting these results together, the wife will be working at age 58 and retired at age 59 only if the actual value of ε_w falls in a range defined by these two values

$$\begin{aligned}&\log(d^b W_b^w) + (\alpha - 1)\log(\tilde{Y}^w_{b|R_h=63}/\kappa) - X_b^w \beta_w \\ &< \varepsilon_w < \log(d^a W_a^w) + (\alpha - 1)\log(\tilde{Y}^w_{a|R_h=63}/\kappa) - X_a^w \beta_w,\end{aligned} \tag{6}$$

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given that the husband retires at age 63. A similar inequality can be developed to bracket the values of ε_h for the husband:

$$\begin{aligned} &\log (d^b W_b^h) + (\alpha - 1) \log (\tilde{Y}^h_{b|R_w=59}/\kappa) - X_b^h\beta_h - \gamma_h \\ &< \varepsilon_h < \log (d^a W_a^h) + (\alpha - 1) \log (\tilde{Y}^h_{a|R_w=59}/\kappa) - X_a^h\beta_h - \gamma_h. \end{aligned} \tag{7}$$

In this inequality, a refers to the year the husband is 62, and b refers to the year he is 63. The $-\gamma_h$ terms are included because the wife is already retired. The rectangular set of values for ε_w and ε_h defined by these two inequalities indicate a situation in which the husband will retire at age 63 if the wife retires at age 59, and vice versa.[16] This rectangular area thus defines a Nash equilibrium. That is, if the wife in the household has a leisure preference ε_w and the husband has a leisure preference ε_h, and if this combination lies within this rectangular area, then each spouse will find it optimal to retire at the specified age, given that the other spouse is retiring at the specified age.

Now suppose that we want to find the location for the [60, 63] area, that is, for the wife retiring 1 year later and the husband still retiring at age 63. The first observation is that the right-hand side of this area is coincident with the left-hand side of the [59, 63] area. This common side is the critical value of ε_w for which the wife will be indifferent between working and retiring at age 59, given that the husband retires at age 63. This means that, horizontally, the [60, 63] area will be immediately to the left of the [59, 63] area, and the two areas will be contiguous but nonoverlapping. The same reasoning applies to the other areas describing Nash equilibria where the husband retires at age 63. These areas are horizontally adjacent with the retirement age of the wife declining as one considers successive cells to the right.

The next issue is what happens to the vertical placement as we move across a row of cells defined by a common retirement age for the husband. That is, as we move across the row [62, 63], [61, 63], [60, 64], [59, 63], [58, 63], how do the upper and lower boundaries of the cells change? Consider first the lower boundary of the cells, for example, the lower boundary of the [59, 63] cell relative to the [60, 63] cell. The main difference is that the [59, 63] cell involves 1 year less income from the wife than does the [60, 63] cell and, hence, has a lower value of $\tilde{Y}^h_{t|R_w}$. The lower boundaries of these cells are determined by the left-hand expressions of inequality (7). The only thing in this expression that changes as we move from the [60,

[16] Note that if the right-hand side of inequality (6) exceeds the left-hand side, there will be no values of ε_w for which the wife will be working at age 58 and retired at 59. The same thing holds true for the husband with regard to inequality (7). In either case, the [59, 63] cell will in essence disappear.

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63] cell to the [59, 63] cell is that the value of $\tilde{Y}^{h}_{t|R_w}$ declines, but only slightly since the value of 1 year's worth of discounted earnings is a small fraction of total lifetime household earnings. Since $\tilde{Y}^{h}_{t|R_w}$ enters the expression with a negative sign, the lower boundary of the [59, 63] cell is slightly higher than for the [60, 63] cell. This implies that, with one exception, as we go across a row of cells to the right, the lower boundary of each successive cell is slightly higher than the previous cell. The same argument applies to the upper boundaries as well.

The one exception is for the pair of cells in which the retirement status of the wife relative to the husband changes. For the row we have been considering, this happens for the [62, 63] and [61, 63] cells. In the [62, 63] cell, the wife would be working when the husband was age 63, but in the [61, 63] year she would be retired. For these cells, the lower boundary represents the value of ε_h for which the husband is indifferent between working and retiring at age 63, as determined by the left-hand expression of inequality (7). For the [61, 63] cell, this expression has a $-\gamma_h$ term (because the wife is retired in this cell) that is missing for the [62, 63] cell (because the wife is working). This in turn implies that the lower boundary of the [61, 63] cell is lower than the corresponding boundary of the [62, 63] cell.[17] A similar argument implies that the upper boundary of the [60, 63] cell is lower than for the [61, 63] cell.

In summary, as you go to the right across a row of cells, the boundaries of each successive cell is higher than for the previous one. The exceptions are that, as you move into a cell with joint retirement (such as the [61, 63] cell), the lower boundary is lower and that, as you move on to the next cell to the right, the upper boundary is lower. A symmetric argument applies as you move up a row of cells that correspond to the same retirement age for the wife. The left and right boundaries for each successive cell are slightly to the right of the cell immediately below it, with the exceptions for the left-hand boundary as you move upward into a cell with joint retirement and for the right-hand boundary as you move further upward into the next cell.

These results have two consequences for figure 2. First, every point will be in at least one cell. This means that there is at least one Nash equilibrium for every combination of the leisure preferences ε_w and ε_h. Second, there are some places in the figure where Nash equilibria overlap. In such cases, we must specify which Nash equilibrium prevails.

Consider first the case for the cell [59, 63]. The cell to the right has a

[17] We are assuming here that the effect of the $-\gamma_h$ term more than offsets the effect of the $(\alpha - 1)\log(\tilde{Y}^{h}_{t|R}/\kappa)$ term. We argued in the previous paragraph that the effect of this latter term is likely to be small since a single year's earnings by one spouse is likely to be only a small proportion of total lifetime household earnings.

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higher upper boundary, and the cell above has a right boundary that is more to the right. This combination of events means that the [59, 62] and [58, 63] cells overlap in the area labeled as *A* in the figure. Let us examine the situation in this area of overlap. Both spouses will want to work until the wife is age 58, at which time the husband is age 60. We assume that both spouses know the preferences of the partner and that the partner can be expected to retire at the age that yields the greatest utility. If the wife were to retire at age 58, she knows that the husband will retire at age 63. This generates enough household income that the wife would want to retire at age 58, which is why this is a Nash equilibrium. If she were to work at age 58 and retire at age 59, the extra household income would cause the husband to want to retire at age 62, also a Nash equilibrium. The first equilibrium is more favorable to the wife, since she gets the extra year's worth of leisure, while the second is more favorable to the husband for the same reason. The husband, however, lacks any creditable means to threaten to retire at age 62 since the wife knows that if she retires at age 58, it is in his best interest to work until age 63. Since the wife can commit to this solution simply by going ahead and retiring at age 58, and since this action ensures the Nash equilibrium of her choice, she will do so. For this reason, the overlap area is included in the [58, 63] cell. This solution, in which each partner considers the best strategy of the other partner, is a subgame-perfect solution.

A second case of overlap is where two joint retirement cells overlap, illustrated by region *B* in the figure. In this area, the [60, 62] cell overlaps with the [61, 63] cell. If the husband retires at age 62, the value of retirement for the wife at age 60 will be higher by γ_w. This additional value of leisure will make it advantageous to the wife to retire as well. The same argument applies to the husband, making this situation a Nash equilibrium. If, on the other hand, the husband works at age 62, the value of retirement at age 60 to the wife will be lower. She now finds that the value of the wage from working more than offsets the lost leisure, and she continues to work. The husband again is in the same situation, making this a second Nash equilibrium. Under these circumstances, it will be advantageous to both for them to retire earlier. By retiring earlier, each spouse boosts the utility of retirement for the other spouse, and they both enjoy a boost from the spouse retirement variable in their respective utility functions. Since either spouse can commit the couple to this equilibrium simply by retiring, they do so. For this reason, we have included this area in the [60, 62] cell.[18]

[18] If γ_w and γ_h are large enough, there is a possibility that three or more of the joint retirement cells may overlap. The same argument would imply that the cell where the spouses retire earlier would be preferred.

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To specify the likelihood function, it is necessary to find the set of values for ε_w and ε_h that generate the observed outcomes for the couples in the sample. For a given retirement date for both the husband and the wife, the set of ε_w and ε_h that generate this result is simply the appropriate area in figure 1, whose boundaries are defined by inequalities (6) and (7). In practice, we observe retirement most precisely at the survey dates. We look for the last survey, when the individual was working full-time, and the following survey, when the individual was retired from full-time work. For instance, the wife might have been working at age 58 in 1986 and retired at age 59 in 1987 and in subsequent surveys. In this case, we infer that the wife retired at age 59.

There are a couple of complications to this procedure. One is that the National Longitudinal Survey was not fielded every year. For instance, we might find that the wife was working at age 58 in 1986 and retired at age 59 in 1987, but we may know only that the husband was working at age 61 in 1987 and retired at age 63 in 1989. Because there was no survey in 1988, we do not know whether the husband retired at age 62 or age 63. In terms of the cells in figure 1, both the cells [59, 62] and [59, 63] are consistent with the observed retirement dates. Therefore, the area of ε_w and ε_h that is consistent with the evidence is the sum of the areas of these two cells.

The other complication is that one or both spouses might still be working during the last survey that is available, that is, during 1989. This is the problem of right censoring, and it is easily accommodated in the model. Suppose that the wife was working at age 58 in 1986 and retired at age 59 in 1987, but the husband was still working at age 63 in 1989. In this case, all that we know is the husband retires from working at age 64 or beyond. That is, the observed pattern of retirement is consistent with the cells [59, 64], [59, 65], [59, 66], and so on down the column. In this case, the area of ε_w and ε_h that is consistent with the data is the area of all of the cells in the column below and including the [59, 64] cell. Alternatively, both spouses might be have been working in 1989, the wife at age 61 and the husband at age 63. Here, we know only that the wife retires at age 62 or later and the husband retires at age 64 or later. The area of ε_w and ε_h that is consistent with this outcome is the entire quadrant below and to the left of the [62, 64] cell.

For family i, let $S_i(\alpha, \beta_w, \beta_h, \gamma_w, \gamma_h)$ be the set of values of ε_w and ε_h in the utility maximization problem that are consistent with retirement between the observed dates. Note that the boundaries of the set depend on the values of the utility function parameters. Further suppose that the values of ε_w and ε_h come from a bivariate normal distribution with density $f(\varepsilon_w, \varepsilon_h | \sigma_w^2, \sigma_h^2, \rho)$, where σ_w^2 and σ_h^2 are the variances of ε_w and ε_h and ρ is the correlation. Using this notation, the log-likelihood function is

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$$\ln \mathcal{L} = \sum_{i=1}^{N} \ln \left[\iint_{S_i(\alpha,\beta_w,\beta_h,\gamma_w,\gamma_h)} f(\varepsilon_w, \varepsilon_h | \sigma_w^2, \sigma_h^2, \rho)\, d\varepsilon_w\, d\varepsilon_h \right].$$

Since the sets S_i are either rectangles or combinations of rectangles, the integrals in the log-likelihood function are evaluated with a standard routine for cumulative joint probabilities of bivariate normal distributions. The likelihood function is maximized using a standard maximization routine, and standard errors for the estimates are calculated by the Berndt-Hall-Hall-Hausman method.[19]

A final complication occurs owing to the presence of spikes in pension accruals. Pension spikes are instances in which the value of the pension jumps substantially and discontinuously at some age, usually the age of early retirement. Because W in the model is compensation, including pension and social security accruals as well as wages, a pension spike means that the value of W (including pension accruals) is much higher in a particular year than for adjacent years.

The complication manifests itself in that, in the year before eligibility for a pension spike, the right-hand of inequality (6) may be less than the left-hand side. For example, suppose that the wife would become eligible for a substantially larger pension if she waits to retire until age 55. Then there is a large spike for working at age 54 since, if she works that year and retires the next year, she will be eligible for a much larger pension. Now consider inequality (6) for the case in which she considers working at age 53 and retiring at age 54. The variable W_b^w, which is the compensation at age 54, is very large in this case since it includes the pension bonus for working at age 54. If it is large enough, the left-hand side of the inequality may be larger than the right-hand side, implying that there are no values of the ε_w preference term that would induce her to retire at age 54. In other words, an individual would not retire just before becoming eligible for a large pension bonus. In terms of figure 1, the entire column of cells corresponding to the wife retiring at age 54 would be absent.[20]

[19] Note that the cells in the likelihood function are determined by the data and do not change as different parameter values are considered. The boundaries of the cells, as defined by inequalities (6) and (7), are continuous functions of the parameters in the preference functions. This means that the integrals in the log-likelihood function are continuous functions of the parameters in the model, facilitating maximization and the calculation of the information matrix.

[20] As one might expect, the data do contain some individuals who retire just before a spike. In order to avoid having these anomalous cases unduly influence the estimated coefficients, the pension spikes are omitted for eight wives and five husbands who retire just before they are eligible to receive them, on the grounds that the associated pensions may well have been defined contribution.

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In this case, the cells for retirement at age 53 would be adjacent to the cells for retirement at age 55. The boundary between these cells would reflect the indifference between retiring at age 53 and age 55. This choice involves comparing the value of leisure at age 53 plus the value at age 54 with the value of working those 2 years:

$$e^{X_t^w\beta_w+\gamma_w L_t^h+\varepsilon_w} + e^{X_{t+1}^w\beta_w+\gamma_w L_{t+1}^h+\varepsilon_w} = U(Y_{t+1|R_h}^w) - U(Y_{t-1|R_h}^w),$$

where t is the year corresponding to age 53 for the wife and $Y_{t+1|R_h}^w$ and $Y_{t-1|R_h}^w$ are the lifetime joint discounted income amounts if the wife retires at age 55 and 53, respectively, given that the husband retires at age R_h. The critical value of ε_w that makes the wife indifferent to retiring at age 53 or age 55, and hence that defines the boundary between the cells, is solved from this equation in the same manner as the derivation in equation (3).

IV. Estimation of the Model

A. The Data and the Variables

The model is estimated using data from the National Longitudinal Survey of Mature Women, 1968–89. The data requirements for estimating the model fall into three categories. First, the dependent variable (retirement) must be measured. As discussed in the previous section, the actual date of retirement does not enter the empirical analysis. Rather, this date is bracketed by the last survey in which the husband or wife is observed to work full time, as described in Section II, and the following survey.

The second category of required variables are the elements of the X vector in the utility function for the husband and wife, year by year. The X vectors contain three elements (besides a constant) for both the husband and wife. These are age, health status, and birth cohort. The age variable is the individual's reported age in 1967, incremented by one for each year. For the binary variable for health status, we examined in each year answers to questions about whether health prevented the individual from working or whether health limited the amount or kind of work that could be done. We look for the first instance in which health was reported as a problem in two consecutive surveys, and the health variable is set to one in all years on or after these two surveys. The idea is to record long-term health problems, and the two-survey requirement is imposed to screen out instances in which there is an isolated survey with reported health problems (a fairly common occurrence in the data). If the problem lasts for two surveys, it is usually apparent in most of the subsequent surveys as well. The variable for birth cohort is simply 1967 minus the age

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in 1967, and is included in case there are secular trends in the disutility of work for different birth cohorts.

The third category of variables includes the compensation streams available for the husband and wife for each year of potential work. These compensation streams consist of three components: wages, pensions, and social security. Details of the construction of the wage offer and pension are in an appendix that is available from us on request. The key features of the imputation process are as follows.

Wages.—For all the survey years except 1968, the survey asks about annual income from wages and salaries, as well as enough information to construct an hourly wage rate. For those years in which the wife is working full time at the time of the survey and for which usable annual wage and salary information is available, the annual wage and salary information is used. For other years, annual wages must be imputed. The imputation process uses the tenure, experience, and health coefficients from an hourly wage regression with fixed individual effects.[21]

Pensions.—The next element of compensation is the pension profile. Information on pensions comes mainly from questions that were asked in 1982, 1986, and 1989. These questions inquired about pension coverage, the ages at which early and normal retirement benefits could be collected, the amounts of those benefits, and the actual amount of current benefits if they were being received.

The full pension is assumed to be determined by the standard defined benefit formula $P = gWT$, where P is the annual pension benefit, W is the final wage, T is years of service, and g is a generosity factor.[22] The generosity figure is calculated on the basis of the individual's expected or actual pension benefits; if no figure is given, we use 1.6%, which is the median figure of plans for which we do have enough information to calculate it. For individuals who retire after the early retirement date but before the normal retirement date, the full pension is reduced by 4.9% per year, which is the weighted average of the reduction rates reported in Hatch et al. (1981), table 4–8. For individuals who retire before the early

[21] The wage equations are estimated separately from the retirement model and without correction for selectivity bias for those who retired. We have, however, eliminated the bias due to the inclusion of partial retirement jobs in the equation (as was discussed in Gustman and Steinmeier [1985*a*]) by focusing on full-time employment and including only full-time employees.

[22] Given the incidence of severe reporting error in the self-reported plan type that we found in Gustman and Steinmeier (1989), we do not attempt in the results presented here to distinguish those with primary defined benefit plans from those with primary defined contribution plans. Instead, in the reported results we have treated all workers as if they were covered by a primary defined benefit plan. Results presented at the end of this section investigate the sensitivity to this procedure.

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retirement date, the reductions are actuarial. This arrangement, which is the basis of the early retirement spike described by Stock and Wise (1990*a*) also appears to be fairly common in the plans in the 1983 Survey of Consumer Finances.[23] We assume that, once begun, firms increase the value of the pensions by 37.9% of the inflation rate, the figure found in Allen, Clark, and Sumner (1986). The value of the pension is the present discounted value of future pension benefits, and pension accrual (which is part of compensation) is the amount by which an additional year's work increases the pension value.[24]

Further details of the pension calculation are presented in the data appendix. Although the imputations are necessarily approximate, they do capture the main effects of pensions on compensation, which are the declines in the accrual rates at the early and normal retirement ages.[25] These calculations do not, however, capture all the variability of the plans, and to that extent there is an error in variables problem in the estimates. Although the consequences of an error in variables problem are more complicated to analyze in the present problem than in a linear regression, the presumption is that the error in calculating the magnitude of pension accruals probably results in the estimated model underestimating the effect of compensation on retirement behavior.

Social Security.—The derivation of social security accruals is less subject to error than are pension accruals, primarily because all elements of the social security formula are known and apply to everyone. The computations do take into account the increases in the normal retirement age and in the delayed retirement credit scheduled to take effect, as specified in the 1983 Social Security Amendments. For the husbands, the computations take into account the effect of his retirement age on the eventual widow's benefits.[26] The present value calculations are similar to those for

[23] For evidence on the prevalence of the spikes, see Gustman and Steinmeier (1989), table 11, which suggests that the accrual in the year of early retirement was at least twice the accrual for adjacent years for the vast majority of defined benefit plans and was over five times the accrual for adjacent years for 25% of the plans.

[24] The real discount rate is taken to be equal to the real growth rate of adjusted hourly earnings. Both this and the expected inflation rate are the average values observed over the 10 years previous to the year in question. The growth rate of adjusted hourly earnings is less than the interest that could be obtained with 10-year treasury bonds over the postwar period, but it is about equal to the interest on 3-month Treasury bills and probably exceeds what most households could obtain with banks or money market funds, especially if after-tax interest is considered.

[25] For discussion of misreporting of early and normal retirement dates in the Survey of Consumer Finances, see Gustman and Steinmeier (1989).

[26] Spouse benefits are not included, however. Owing to the progressivity of the social security benefit formula, the wife's earnings need to be only about a third of the husband's earnings in order for the benefits based on own earnings to dominate spouse benefits, and this will generally be true for the career wives in this model.

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Table 2
Model Estimates Treating Spouse Retirement as Exogenous (N = 564)

	No Interdependence		Interdependence	
	Wife's Equation (1)	Husband's Equation (2)	Wife's Equation (3)	Husband's Equation (4)
α Consumption	−1.549	−1.355	−1.563	−1.256
	(−3.13)	(−2.35)	(−3.15)	(−2.27)
β_0 Constant	−19.042	−18.350	−19.401	−17.489
	(−21.83)	(−11.32)	(−20.82)	(−10.83)
β_1 Age	.578	.650	.528	.599
	(4.52)	(3.24)	(4.40)	(3.25)
β_2 Health problem	1.050	1.974	1.036	2.005
	(2.82)	(3.04)	(2.79)	(3.09)
β_3 Birth cohort	.101	.127	.094	.108
	(2.20)	(2.28)	(2.08)	(2.08)
γ Spouse retired			.953	1.302
			(3.05)	(2.71)
σ_ε SD of ε	2.878	3.427	2.864	3.404
	(4.79)	(3.72)	(4.73)	(3.80)
Log likelihood	−668.2	−743.4	−658.67	−732.72

NOTE.—Figures in parentheses are asymptotic t-statistics. For age and vintage, the actual variables are (age − 55) and (vintage − 30).

the pensions, and the social security accrual, which is the amount by which an additional year's work increases the present value of social security benefits, is included in compensation.[27]

The overall compensation paths for the wife and the husband are calculated by adding to the wage the accruals for social security and, if appropriate, the pension. These are then combined with the retirement ages of both spouses and the values of the variables in X to provide the data set for estimation. The final data set has 564 observations of couples who satisfied the inclusion criteria and who had at least one wage and salary figure on which to base the compensation paths.

B. Estimation

The estimates for various forms of the model are given in tables 2 and 3. Table 2 reports on results when the spouse's retirement is ignored or is treated as exogenous. Table 3 reports on estimation of the model on the assumption that retirement is jointly determined, applying the estimation procedure outlined in Section III above. The estimated parameters in these tables include the exponent of the consumption term in the utility

[27] For further discussion of the social security rules and estimates of the incentives they create, see Gustman and Steinmeier (1985*b*, 1991).

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Table 3
Model Estimates with Retirement Jointly Determined (N = 564)

	(1)	(2)	(3)	(4)
Consumption:				
α	−1.465	−1.427	−1.612	−1.534
	(−4.13)	(−4.00)	(−4.39)	(−4.04)
Wife's parameters:				
β_0 Constant	−18.151	−17.762	−19.410	−18.615
	(−23.63)	(−23.42)	(−32.75)	(−26.78)
β_1 Age	.566	.555	.542	.531
	(4.91)	(4.89)	(5.94)	(5.19)
β_2 Health problem	1.019	1.003	1.005	.981
	(2.96)	(2.96)	(3.30)	(3.06)
β_3 Birth cohort	.099	.096	.088	.084
	(2.22)	(2.16)	(2.21)	(2.01)
γ Husband retired		.092		.095
		(.27)		(.27)
σ_ε SD of ε_w	2.821	2.787	2.761	2.713
	(5.33)	(5.40)	(6.16)	(5.78)
Husband's parameters:				
β_0 Constant	−19.560	−19.383	−20.744	−20.031
	(−13.41)	(−12.71)	(−17.60)	(−15.67)
β_1 Age	.670	.633	.632	.613
	(3.67)	(3.63)	(4.32)	(4.07)
β_2 Health problem	2.043	2.119	2.017	2.046
	(3.41)	(3.38)	(3.91)	(3.71)
β_3 Birth cohort	.130	.114	.126	.109
	(2.43)	(2.19)	(2.69)	(2.29)
γ Wife retired		1.256		.582
		(2.15)		(1.12)
σ_ε SD of ε_h	3.530	3.572	3.411	3.394
	(4.25)	(4.21)	(5.06)	(4.76)
Correlation:				
ρ			.312	.236
			6.46	4.13
Log likelihood	−1,411.80	−1,401.11	−1,397.43	−1,394.47

NOTE.—Figures in parentheses are asymptotic t-statistics. For age and vintage, the actual variables are (age − 55) and (vintage − 30).

function (α), the coefficients of the linear forms for both the wife and the husband (the β's), the coefficient of the spouse retirement variable (the γ's), the variances in retirement tastes for both the wife and the husband (the σ's), and when retirement is treated as jointly determined, the correlation of these tastes (ρ). The β vectors for both the wife and the husband include a constant, age, a binary variable for the presence of a health problem, and the birth cohort of the individual.

The first two columns of table 2 contain estimates for the wife and the husband separately, omitting any variables that might link the two retirement dates. In both cases, the earnings of the remaining spouse are taken as exogenous. All of the variables are significant at conventional levels. The coefficients on the consumption terms indicate, for both partners, a moderate desire to smooth consumption over time. For this parameter, a

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value of unity would indicate no desire to smooth consumption over time, while a large negative value would indicate a great desire to smooth consumption. Since the difference between the wife's parameter and the husband's parameter is less than their standard errors, these two values are unlikely to be significantly different.[28]

For the wife, the coefficient of the age term is 0.578. This indicates that the utility of retirement is rising by about over 78% per year during the period of retirement.[29] The procedure estimates this effect primarily by looking at how much retirement is concentrated in years in which compensation falls considerably (mainly years with large reductions in pension and/or social security compensation). In terms of inequalities (6) and (7), years with large declines in compensation will have relatively wider intervals, and hence the probability of retirement will be higher in those years. If the coefficient of age is smaller, then the relative size of the intervals with large declines in compensation will be higher, which will increase the probability of retirement in those years.

Among the other parameters, a health problem has the same effect on retirement as about 2 years of age, and the effect of birth cohort is modest. The standard error of the retirement taste term ε is 2.878, which amounts to over five times the coefficient of the age term. Given the coefficient of the age variable, the variance of retirement tastes is identified by the variance of retirement ages.[30] If σ_ε were small, the model would predict that most wives would retire at approximately the same age, and if it were large, the model would predict a wide dispersion of retirement ages. From the estimate, it is fairly clear that the taste term plays a very large role in accounting for the large range of ages at which various individuals retire.

For the husband, the value of the health coefficient amounts to a little over three times the magnitude of the coefficient of the age term, and the standard deviation in tastes for retirement is a little over five times the size of the coefficient of the age term. The age term itself is somewhat larger than it is for the wives. This may reflect two possibilities. First, the

[28] For the difference to be significant, the correlation between the two estimates would have to be (algebraically) less than −0.84. The only source of this correlation is indirect: the wives from the first column and the husbands from the second column come from the same sample. In the absence of any other mechanism that would generate a negative correlation among these two coefficients, it seems unlikely that any negative correlation would be large enough to make the estimates significantly different.

[29] This is calculated as $(e^{0.578} - 1)$ times 100%.

[30] Normally, the error terms in probit models such as equations (4) and (5) are not identified and must be normalized to unity. However, both these equations contain a term of the form $\log(d^t W_t)$, without a coefficient. It is the implied coefficient of this term that is normalized to unity, rather than the variance of the error term.

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husbands may be less sensitive to a given percentage change in monetary incentives to retire. From the discussion above, a higher coefficient on the age term implies that the husbands are more likely to retire at ages determined by their values of ε, regardless of changes in compensation incentives. Alternatively, the high coefficient may arise if the ages of compensation decreases are mismeasured, which would reduce the correlation between retirement and compensation decreases. It is plausible that such mismeasurement may be more severe for husbands than for wives since the wives and not the husbands were the primary respondents in this data set.

The last two columns of table 2 continue to treat the spouse's retirement behavior as exogenously determined, but for each spouse the preference for leisure depends on the retirement status of the other. For both equations, the spouse's retirement status has a significant effect on the valuation of leisure, with the effect of the spouse being retired increasing the value of leisure by an amount equivalent to about 2 years of age. There is only a small effect of including the spouse's retirement status on the other parameter estimates.

If each spouse's retirement decision is influenced by the retirement status of the other, however, then treating the decision of the spouse as exogenous will lead to an overstatement of the effect of the retirement status of one spouse on the retirement decision of the other. For instance, the wife may tell the husband, "If you retire early, I will too, and we can enjoy our retirement years together." The husband, meanwhile, may be thinking the same thing, and both husband and wife of this couple will retire early. To the researcher studying only the wife and taking the husband's retirement as exogenous, it will appear that an early retirement by the husband is associated with an early retirement by the wife. In fact, the early retirement of the husband is partly the result of the wife's own preferences, which will be mistakenly attributed to the husband's retirement.[31]

Moreover, the preferences of the two spouses may be correlated. Suppose that men and women find individuals with like preferences for leisure attractive and tend to marry. To the extent that this is true, men and women who enjoy lots of free time will tend to marry one another, as will men and women who are workaholics. Alternately, a similarity in tastes for leisure can develop during a marriage. If individuals who have

[31] Notice also that the results of the retirement decisions made by each spouse, as estimated in columns 3 and 4 of table 2, should not be taken as additive. If the estimates treat the spouse's retirement choice as exogenous, each equation by itself will explain whatever joint peak there is in retirement outcomes. Together, the estimates are likely to "overexplain" any joint retirement behavior if the decisions are in fact interdependent.

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like preferences for leisure tend to be married to one another, then the retirement age of the spouse will be correlated with the individual's own preferences. Again, investigators who take the husband's retirement as exogenous will observe that, if the husband retires early, the wife is likely also to retire early. Thus it may mistakenly be concluded that the husband's retirement has a large influence on the retirement date of the wife, when in fact it is the correlation in retirement preferences that is driving both retirements.

The estimates in table 3 are designed to deal with these issues. The first column of table 3 provides a basis for comparison with the first two columns of table 2. It imposes the restriction that the consumption parameter is the same between husbands and wives (which is necessary if the couple is to share a common consumption stream) but, as in columns 1 and 2 of table 2, excludes the indicator of whether the spouse is retired. The resulting coefficient of α is about halfway between the estimates for wives and husbands in columns 1 and 2 of table 2. The values of the likelihood statistics indicate that the imposition of this constraint is not statistically significant.[32]

Column 2 of table 3 looks again at the possibility that spouses might find retirement more attractive if the other spouse is retired by including spouse retirement variables in the leisure preference term of the utility functions. The difference between these results and those in columns 3 and 4 of table 2 is that here the spouse's retirement status is treated as endogenously determined. In these results, the coefficient of the husband's retirement status affecting the wife's retirement becomes small and insignificant. The coefficient for the wife's retirement status in explaining the husband's retirement, however, has an estimated t-statistic of over 2. This coefficient indicates that, for husbands, having a wife that is retired has the same effect on the desirability of retirement as does being about 2 years older.

These estimates suggest that the husband's retirement does not affect the retirement preferences of the wife, but the wife's retirement has a notable effect on the retirement preferences of the husband. An ex post rationale for this result is that some husbands do not wish to find themselves with more time to take care of the household while the wife is still devoting a substantial part of her time to market work. An anonymous referee has suggested an alternative rationale: a husband may feel a perceived need to "support" the couple, and he is reluctant to retire first before he knows for sure how long the wife will work and how much

[32] The likelihood ratio test statistic is 0.40, vs. a 5% critical value of 3.84.

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income she will contribute to the lifetime family total.[33] In any case, stronger confirmation of this result and investigation of further implications would be required before any firm conclusion is drawn.

Column 3 looks at an alternative explanation for couples retiring at around the same time. If men and women with like preferences for leisure tend to marry one another, the values of ε_w and ε_h are correlated with each other. To reflect this correlation, column 3 introduces the correlation parameter ρ into the estimation (and omits the γ's). As can be seen from the table, the estimated value of ρ is about 0.3, and it is highly significant.

Finally, column 4 allows these two competing explanations to be included simultaneously in the same equation. Compared to column 3, the value of ρ is now only about three-quarters as large, but it is still highly significant. The spouse-retired coefficients now both have the proper sign, but neither one has a t-statistic above 1.2. However, the combined effect of the two of them is marginally significant, with a likelihood ratio test statistic of 5.94 versus a 5% critical value of 5.99. Although the estimation procedure is unable to separate out the spouse-retirement coefficients, they are jointly significant. Moreover, the point estimate of the coefficient on the spouse-retirement variable is over six times as large for the husband than it is for the wife.[34] Because the relative effects of the γ's and ρ cannot be inferred simply by comparing the relative size of the parameters, that issue will be investigated by simulation.[35]

For the last specification, we comment briefly on the magnitudes of the other parameters in the model. The magnitude of α in this specification is

[33] Other papers (e.g., Reimers and Honig 1996) have investigated gender differences in preference functions.

[34] In a separate estimation, we include education in both X vectors. The education coefficients were not themselves significant, and most of the other coefficients were very little changed. The only exceptions were moderate, and roughly offsetting, changes in the spouse-retirement variables. The variable γ_w increased to 0.22, and γ_h declined to 0.39. These results serve to reinforce the admonition that although these γ coefficients are jointly significant, they are not individually very precisely estimated.

[35] Identification of these effects comes by examining the peak of joint retirement. To the extent that the cause of the peak is the spouse retirement variables, there should be a narrow peak of couples retiring at exactly the same date. To the extent that the cause is a correlation of preferences, there should be a broad peak of couples who retire within a few years of each other but not necessarily at exactly the same time. Separate identification of the two spouse-retirement variables comes by examining when the joint retirement tends to occur. If joint retirement occurs at the time the wife (but not the husband) has strong financial incentives to retire, this would indicate that it is the husband who values having the wife at home. If it occurs when the husband has incentives to retire, the reverse would be true.

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slightly greater (in absolute value) than in the specification without the correlation of the spouse-retirement variables (-1.53 vs. -1.46). The coefficients in the β vector for the wife look very similar to the coefficients for the specification with no spouse interactions included (col. 1 of table 3). The same is true for the coefficients in the β vector for the husband.

C. Sensitivity to Pension Calculations

A final issue in the estimation of the model is the sensitivity of the estimates to the manner in which pension accruals are calculated. In the estimates reported in table 3, all pensions were assumed to be defined benefit. Benefits are based on a generic formula involving years of service and final wages. An alternative assumption is that individuals who say that they have defined contribution plans in fact do. In 1989, the survey asked the wife whether each spouse's most important pension, either in the current job or in a past job, was based on "a definite formula based on years of service or salary" or on "the amount of money in your account." The respondents report that 12% of the women and 10% of the husbands have "money in your account" plans. The alternative estimates assume that these individuals have defined contribution plans and that the pension accrual is simply the amount that the firm contributes to the plan in a given year. All other plans are treated as defined benefit plans whose accruals are calculated exactly as before.

Table 4 reports on the difference this alternative assumption makes. For convenience, column 1 repeats the last column of table 3 and assumes that all plans are defined benefit. Column 2 assumes that the plans are defined contribution for husbands and wives who say that benefits are based on "the amount of money in your account." A comparison of these two columns reveals few differences with the exception that the coefficient of the spouse-retired variable in the husband's utility function is somewhat higher.

Column 3 of table 4 reports on another approach. In this column, all plans are again taken to be defined benefit. However, the increase in value at the early retirement date is calculated by a somewhat different method. Rather than generating this increase by assuming that benefits are reduced more for employees who leave before the early retirement age, this approach simply assumes that, at the early retirement age, benefits increase by 13%. This figure comes from an analysis of the employer-provided pension plans collected in conjunction with the 1989 Survey of Consumer Finances, as reported in Anderson, Gustman, and Steinmeier (1999). The results in this column are very close to those in column 1.

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Table 4
Sensitivity of Estimates to Pension Assumptions (N = 564)

	(1)	(2)	(3)
Consumption:			
α	−1.534	−1.523	−1.487
	(−4.04)	(−4.06)	(−4.80)
Wife's parameters:			
β_0 Constant	−18.615	−18.434	−18.060
	(−26.78)	(−27.77)	(−32.79)
β_1 Age	.531	.536	.513
	(5.19)	(5.34)	(6.16)
β_2 Health problem	.981	.988	.941
	(3.06)	(3.14)	(3.37)
β_3 Birth cohort	.084	.088	.080
	(2.01)	(2.11)	(2.03)
γ Husband retired	.095	−.096	.116
	(.27)	(−.29)	(.37)
σ_ε SD of ε_w	2.713	2.653	2.616
	(5.78)	(.45)	(6.84)
Husband's parameters:			
β_0 Constant	−20.031	−20.096	−19.321
	(−15.67)	(−14.81)	(−19.77)
β_1 Age	.613	.622	.585
	(4.07)	(3.92)	(5.05)
β_2 Health problem	2.046	2.090	1.956
	(3.71)	(3.65)	(4.33)
β_3 Birth cohort	.109	.112	.102
	(2.29)	(2.25)	(2.35)
γ Wife retired	.582	.891	.521
	(1.12)	(1.76)	(1.13)
σ_ε SD of ε_w	3.394	3.495	3.249
	(4.76)	(4.60)	(5.85)
Correlation:			
ρ	.236	.230	.238
	4.13	(3.80)	(4.00)
Log likelihood	−1,394.47	−1,395.07	−1,396.60

Note.—Figures in parentheses are asymptotic t-statistics. For age and vintage, the actual variables are (age − 55) and (vintage − 30).

V. Simulations of the Effects of Husband Wife Retirement Interactions

The model parameters do not indicate the relative importance of the interdependence of retirement decisions and correlation of tastes in shaping retirement outcomes. The simulations in this section will shed more light on this issue.

The simulations are performed as follows. First, the paths of the X vectors and the compensation stream for both husband and wife are calculated as indicated in the first part of the preceding section. The model parameters are taken from the last column of table 3, that is, from the full model. Given the estimated variances of the error terms and the correlation between them, a random draw is made from a bivariate normal

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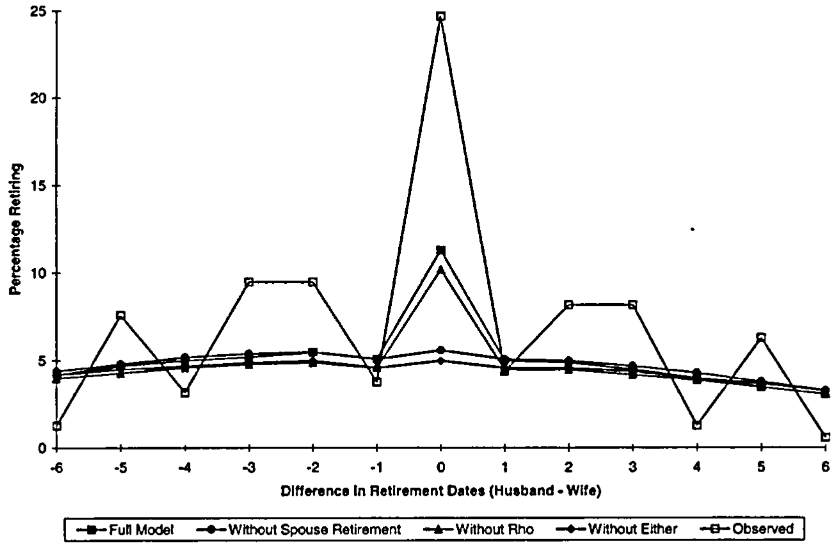

FIG. 3.—Effects of joint retirement variables

distribution to obtain ε_w and ε_h. The values of the X vectors, the compensation streams, α, the β vectors, the γ coefficients, and the two ε's then imply specific retirement ages for the wife and the husband.

Figure 3 reports the results of the simulations. The figure indicates the differences in retirement dates between the husband and wife under alternative specifications for the model. The line plotted with shaded squares corresponds to the full model, including the effects of ρ and the spouse-retirement variables. For this model, there is a sharp peak at zero difference in retirement dates, with over 11% of the couples retiring at the same time, whereas for other age differences, the probability ranges around 4%–5%.

For comparison, the line in figure 3 plotted with open squares gives the distribution of observed retirements, taken from the data used in figure 1. Relative to the simulated retirements, the observed retirements have two notable features. First, the level of observed retirements is substantially higher than the level of simulated retirements for cases in which the spouses retire within 3 years of one another. This is likely to be a consequence of selection. The couples were relatively young in 1989, and for only about 25% of the sample were both spouses observed to have retired. If either spouse chose a late retirement age, chances are at least one spouse was still working in 1989, and hence the couple is not included among the observed retirements in the figure. A more significant feature of figure 1 is that the relative size of the central peak at simultaneous retirement is a little over twice the size of nearby points on the distribu-

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tion.[36] This means that couples retire at the same time more than twice as often as retiring 2 or 3 years apart. This pattern mirrors the corresponding pattern of the full-model simulations.

It is clear from the remaining simulations in figure 3 that the source of interdependence in retirement is in the coordination of preferences among spouses and is not due to the correlation of incentives in the compensation paths facing husbands and wives. The principal source of correlated incentives is if both spouses have pensions with retirement dates occurring in the same year. However, when all sources of interdependence in the utility function are suppressed (but the opportunity sets remain unchanged), joint retirement essentially disappears, as indicated by the line with diamonds in figure 3.

Investigating the source of the interdependence within the utility function, it can be seen that the peak in the probability of retiring at the same age remains when ρ (the correlation between ε_w and ε_h) is set equal to zero, falling by only about 1 percentage point (the results with triangles in figure 3). The conclusion is that the modest estimated correlation between ε_w and ε_h produces at most a modest increase in the tendency of couples to retire around the same time. On the other hand, setting the spouse retirement coefficients (the γ's) equal to zero but retaining the value of ρ (the results with circles) reduces the tendency for couples to retire together from about 11% to about 5%.[37] In this simulation, retirement at exactly the same year is only a little above retirement at dates which are a year or two apart, in marked contrast to either situation that includes the spouse retirement variables. Moreover, retirement at dates that are a year or two apart (but not the same) is little affected as compared to the simulations in which the γ's are included.

In sum, from the simulations it is clear that most of the spike at 0 years difference in retirement dates is due to the spouse retirement variables. Dropping ρ diminishes this peak only slightly, but dropping the γ's

[36] The dips in the observed distribution at ± 1 years is an artifact of the survey. In most years the NLS was an every-other-year survey, so couples were less likely to be observed retiring 1 year apart. Couples who did retire 1 year apart were likely to be counted as retiring at the same time (if both retirements occurred between two surveys) or 2 years apart (if the one spouse retired before a survey and the other retired after the same survey). The dips in the observed distribution at ± 4 years and ± 6 years occur for the same reason.

[37] Simultaneously, the constants in the linear forms $X\beta$ are increased to offset the omission of the spouse-retirement variables. Otherwise, omitting the spouse-retirement variables will reduce $X\beta$ generally and will lead to an increase in the average retirement age. Since the spouse retirement variables average one-half around the years of the retirement decision, the constant terms in the linear forms $X\beta$ are increased by one-half of the corresponding γ parameters.

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almost eliminates it. The reverse seems to be true for differences in retirement dates of 1 year or more: in this case, the difference in retirement dates seems to be due mostly to the correlation between ε_w and ε_h. Dropping the γ's has very little effect on those differences, but dropping ρ lowers them to about the level found in the model in which all interdependence is suppressed.

VI. Summary and Conclusions

This paper has specified and estimated a structural retirement model in which retirement decisions by husbands and wives are jointly determined. The parameters estimated for the model generate behavior that brings the retirement dates of husbands and wives closer together than would otherwise be the case, with the probability of retirement at the same time being about 11% of couples.

The correlation of retirement preferences is a significant factor in increasing the joint retirement of spouses. The increase in leisure value from having a spouse retired is also significant in the data, although the estimation procedure is unable to separate out the precise values of the two spouse-retirement coefficients. Simulation indicates the spouse-retirement explanation is quantitatively more important in increasing the joint retirement outcomes of spouses. In contrast, we do not find any support for the hypothesis that coordination in retirement of spouses results from coordination in the incentives created by the spouses' opportunity sets. Once the joint retirement terms are removed from the utility function, simulation indicates that joint retirement occurs no more frequently than retirement in other years. In short, we find that joint retirement is due to preferences and not to the budget sets.

There is some suggestion in the data that the wife's retirement decision is not strongly influenced by the husband's, but the husband's decision is more strongly influenced by the wife's. Although such a result is consistent with an interpretation that the husband would rather not face the house and related work load alone, this result is a preliminary suggestion that requires further support.

Finally, because the National Longitudinal Survey of Mature Women provides a recent, nationally representative longitudinal sample available for a study of retirement behavior, the results reported in this study reflect the labor market trends shaping the retirement behavior of women. Although many members of the cohorts included in the NLS have not yet retired, the estimating technique has explicitly accounted for incomplete employment spells.

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Data Appendix

I. Wages

To construct the wage profile for the wives, we begin at the last observation of full-time annual wages and salaries. This figure is projected forward on the basis of the tenure, experience, and if appropriate, health coefficients in fixed-effects wage regressions to be discussed shortly. It is also projected backward on the basis of these coefficients until the next observation of full-time wages and salaries is encountered. That observation is used and is projected backward until the next observation is encountered. This process is repeated for each successive annual wage and salary observation. For years before the beginning of the survey, there may be a time before the start of the job held at the beginning of the survey when we do not observe the sequence of jobs and, hence, do not know the tenure levels. In this case, we assume that such years formed a single job.[38] In the beginning year of the survey the wife is explicitly asked how many years she has previously worked for more than 6 months; if the response to this question indicates insufficient experience to fill in the wage profile back to age 25, the wife is assumed to have been out of the labor force in the remaining years.

Construction of the wage profile for husbands follows a similar strategy as for the wives, except that it is the age coefficients that are used to project wages between actual observations of annual wages and salaries (tenure and experience variables are not always available for the husbands). For the years before the beginning of the survey, the wages were projected backward until age 25, the beginning year of the period used in both the estimation and simulations.[39]

The hourly wage regressions, from which the tenure, experience, and health coefficients are used to construct the wage profiles, are estimated based on usable hourly wage observations in non-self-employed jobs. For each observation, variables are created for education, health status, residence (central city, suburban, rural, and south or nonsouth), industry (nine categories), and occupation (three categories). These variables are measured at the time of the survey. In addition, imputed tenure and

[38] This assumption probably does not matter a great deal since it has only a minor effect on the total lifetime earnings (Y) and no effect on annual compensation (W) in any year used in calculating the retirement values of ε.

[39] There would be a problem with this strategy for calculating the wage profile if either the husband or the wife did not have any valid observations for full-time annual wages and salaries. This does not often happen if the couple met the other selection criteria, but in the relatively few cases where it does, the couple is excluded from the sample. It might have been possible to project the wages from the wage equations, but the estimated R^2 of the wage equations leaves plenty of room for large errors in the imputation process. Basically, if there are no observations to pin down whether we are talking about a high-wage or low-wage worker, the entire profile may be very poorly located, and in such cases we deemed it advisable to omit the couple from the sample.

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experience variables are used. For tenure, the NLS lists a unique employer number for each job, so that it is possible to see whether the wife worked with the same employer in previous years. The beginning date of the job is the survey date the wife first worked for that employer, unless the wife worked for that employer in the first survey (in which case, the beginning date is calculated from a question in the first survey about the length of time the wife had been with that employer). Once the beginning of the job is established, tenure is calculated as the time from the beginning of the job to the survey in question.[40] A similar approach is taken to construct the experience variable. In the first survey, the wife was asked how many years of full-time work she had engaged in before that survey. The experience variable simply increments this value by one or two (depending on the length of time between surveys) if the wife reported working full-time at the time of the survey.

The resulting (log) hourly wage regression for the wives is presented in table A1. Many of the variables are significant, and most have the expected sign. The second-order terms of experience and tenure indicate that both have the expected concave shape. The effect of experience peaks after only 28 years, but this is counteracted to some extent by tenure peaking after 54 years. The R^2 of this regression is 50%, which is certainly respectable for a wage regression.

Since several observations for each individual are included in the regression, it is likely that the regression contains a fixed effect, meaning that some individuals consistently earn more because of factors not included in the wage regression, and others less. Such a fixed effect may cause the standard errors in the regression to be understated, and if it is correlated with other explanatory variables, it may lead to biased estimates as well. Table A2 presents estimates which allow for the fixed effects among individuals. This regression drops out education since any variable that is constant for a particular individual cannot be distinguished from the fixed effect. The results for the health, residence, industry, and occupation variables show widespread reductions from the values found in the previous regression. The linear term in experience is unchanged, but the second-order term now suggests that the effect of experience peaks at around 40 years. Both the linear and second-order tenure terms are reduced by about a third, but they still indicate a peak in the effect of tenure at a little over 50 years.

For the husbands, a similar strategy is followed, except that there is not as much information for the husband in the survey. In every survey year except 1968, the survey asks about the wage and salary income of the husbands over the previous 12 months (or sometimes the previous cal-

[40] This method of calculating tenure will produce consistent numbers across different surveys. This eliminates inconsistencies where, e.g., the individual reports that he has worked for the employer 10 years in one survey and, when asked the same question 2 years later, responds that he has worked 9 years in the later survey.

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Table A1
Wage Regression for Wives

	Coefficient	t-Statistic	Mean
Constant	.476	11.84	
Education:			
Years of education	.043	11.14	11.8
High school graduate	−.007	−.50	.694
Years of college	−.010	−1.41	.755
College graduate	.057	2.13	.133
Health problem	−.082	−7.73	.139
Residence:			
Central city SMSA	.152	16.31	.327
Suburban SMSA	.158	17.25	.347
South	−.126	−15.70	.411
Years of experience	.015	8.61	20.5
Square of experience/100	−.027	−6.93	505
Years of tenure	.013	8.24	9.9
Square of tenure/100	−.012	−2.36	159
Industry:			
Agriculture, forestry, and fishing	−.233	−5.17	.007
Mining	.212	3.06	.003
Construction	.036	.89	.009
Transport and communication	.146	6.80	.036
Wholesale and retail trade	−.230	−17.87	.146
Finance, insurance, and real estate	−.061	−3.59	.070
Services	−.132	−12.61	.439
Public administration	.074	4.28	.065
Occupation:			
Management and professional	.384	29.93	.273
White collar	.173	16.22	.379
Dependent variable:			
Log of hourly wage			1.390
Number of observations		7,317	
R^2		.5036	

NOTE.—SMSA = standard metropolitan statistical area.

endar year). This information is much the same as was collected from the wives. Also, the section on other household members collected information about the husband's occupation, if he was working. The surveys did not collect regular information about the industry of the husband's employer. Also, they did not regularly ask about the length of the husband's stay with an employer, nor were we able to tell whether the husband had been with the same employer as in the previous survey. This means that it is not generally possible to construct a tenure variable.

As a result, the wage regression for husbands omits experience, tenure, and industry and adds age instead.[41] The results are presented in table A3. Again, many of the variables are significant and of the expected sign. The

[41] We could have used an experience variable rather than age, but if experience

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Table A2
Fixed Effects Wage Regression for Wives

	Coefficient	t-Statistic	Mean
Health problem	−.030	−3.58	.139
Residence:			
Central city SMSA	.019	.79	.327
Suburban SMSA	.043	1.88	.347
South	−.073	−2.22	.411
Years of experience	.015	10.51	20.5
Square of experience/100	−.018	−5.88	505
Years of tenure	.009	6.88	9.9
Square of tenure/100	−.008	−2.01	159
Industry:			
Agriculture, forestry, and fishing	−.123	−2.87	.007
Mining	.032	.40	.003
Construction	−.039	−1.13	.009
Transport and communication	−.018	−.65	.036
Wholesale and retail trade	−.131	−8.47	.146
Finance, insurance, and real estate	−.042	−1.77	.070
Services	−.119	−8.27	.439
Public administration	−.048	−2.31	.065
Occupation:			
Management and professional	.061	4.73	.273
White collar	.004	.31	.379
Dependent variable:			
Log of hourly wage			1.390
Number of observations		7,317	
R^2		.8265	

NOTE.—Regression includes dummy variables for repeated observations on each individual. SMSA = standard metropolitan statistical area.

relative magnitudes of the linear and second-order age terms indicate that the effect of age peaks at around 50. The results of the fixed-effects regression are presented in table A4. This regression sharply reduces the effects of health and occupation but not of central city or suburban location. The age coefficients are about 10%–20% lower, but they still indicate that the peak effect of age occurs at around 50-years-old.

II. Pensions

We are particularly concerned with pensions on the last job before retirement since these pensions contain incentives relevant for the retirement decision. We are in relatively good shape if the individual worked until at least 1982. In that case, we can tell reasonably well whether the individual retired under a pension. The years of service in the job is available in most instances. In many cases we can tell the age they were

is defined as (age − education − 5), the two variables are picking up the same effect, given that education is also in the regression.

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Table A3
Wage Regression for Husbands

	Coefficient	t-Statistic	Mean
Constant	.021	.10	
Education:			
Years of education	.049	9.50	11.8
High school graduate	.048	2.02	.656
Years of college	−.016	−1.55	1.04
College graduate	−.028	−.71	.178
Health problem	−.113	−5.55	.104
Residence:			
Central city SMSA	.184	11.42	.257
Suburban SMSA	.209	14.49	.407
South	−.168	−12.59	.370
Age	.047	5.82	49.2
Square of age/100	−.051	−6.09	24.83
Occupation:			
Management and professional	.211	12.44	.325
White collar	.073	3.61	.124
Dependent variable:			
Log of hourly wage			1.809
Number of observations		4,575	
R^2		.3120	

NOTE.—SMSA = standard metropolitan statistical area.

first eligible for a pension, and we can get at least one figure as to the amount of the expected pension. However, the information on the normal retirement age appears in general to be less reliable, and very few indi-

Table A4
Fixed Effects Wage Regression for Husbands

	Coefficient	t-Statistic	Mean
Health problem	−.054	−3.18	.104
Residence:			
Central city SMSA	.220	6.31	.257
Suburban SMSA	.221	7.00	.407
South	−.120	−2.89	.370
Age	.042	7.33	49.2
Square of age/100	−.042	−7.07	24.83
Occupation:			
Management and professional	.004	.26	.325
White collar	−.022	−1.07	.124
Dependent variable:			
Log of hourly wage			1.809
Number of observations		4,575	
R^2		.7224	

NOTE.—Regression includes dummy variables for repeated observations on each individual. SMSA = standard metropolitan statistical area.

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viduals provided enough information to be able to infer how much pensions are reduced for early retirement.[42]

Faced with this situation, we proceed as follows. For individuals who were covered on their last jobs before retirement, we use the last figure they reported as the early retirement age. If no figures are reported, we use age 55.[43] If the individual reported that he or she was receiving benefits after the last year of full-time work but before the reported early retirement age, the early retirement age was adjusted downward to be consistent with the reported benefits. The normal retirement age, about which we have relatively little information, is taken to be 62 except if the individual retired around age 65, in which case the normal retirement age is taken to be 65.[44] For women, the tenure is the tenure calculated for the wage profiles, and for men, if no tenure is given in the pension section, tenure is measured from age 25.

For individuals who retired before 1982, we have much the same information about the pension, but the data do not indicate which job is associated with the pension. For women who retire before 1982 and report that they had a pension, the pension is considered to have come from the latest job if that job lasted for longer than 5 years.[45] For the husbands, we have little choice but to assume that, if they retired before

[42] Of the women with a pension in the sample, 15% did not report a normal retirement age (which was asked only in 1989), and of the remainder, 41% reported an age of 59 or less. Prior work (Gustman and Steinmeier 1989), based on pension documents supplied by firms, suggests that the true figure is probably less than 20%. In the 1989 survey, the question about the normal retirement age was, "What is the youngest age or the minimum years of service at which you could receive or did receive full retirement benefits from your main or basic pension plan?" This question was asked before any questions about the early retirement age, and it seems that many respondents may have heard the words "minimum years" and interpreted this as a question about the age at which they were first eligible to receive benefits under the plan. This suspicion is reinforced by the fact that most of the answers of those 59 or younger were in fact at age 55, which in the previous study was found to be by far the most common age for early retirement.

[43] Age 55 is the most common early retirement age among those who do report an early retirement age. The distribution of cases is as follows: total pensions for wives = 399, of which the early retirement date is imputed in 48 cases; total pensions for husbands = 319, of which the early retirement date is imputed in 133 cases.

[44] In previous work (Gustman and Steinmeier 1989), we found that age 62 was the median age for normal retirement, with a very noticeable concentration at age 65.

[45] If the latest job lasted less than 5 years, previous jobs are searched for the one whose tenure came closest to matching the tenure given in the pension questions. If no tenure was given in the pension questions, the pension is taken to come from the longest previous job. Of these pensions, 22 are imputed to the last full-time job lasting more than 5 years, 10 are imputed to a previous job on basis of years of service, and 3 are imputed to the longest previous job.

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1982 and had a pension, the pension came from the last full-time job. If it appears that the pension did come from the last job, the calculations of the value of accruals proceed in the same manner as outlined above.

If the pension is from a job previous to the last job, the incentives from the pension do not affect the retirement decision directly. The only effect of these pensions on retirement is through a wealth effect. For these individuals, pension wealth can be calculated from the size of the pension and the length of time the individual has been collecting it, which we know for most such individuals. In cases of missing information, the pension amounts and/or the period of collection are constructed along the lines detailed for individuals who receive pensions on their last job.

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