The Economics of Retirement: A Nontechnical Guide

*by Michael V. Leonesio**

Concern about the economic consequences of the aging of the United States population has prompted considerable research activity during the past two decades. Economists have carefully examined retirement patterns and trends, and sought to identify and measure the determinants of the timing of retirement by older workers. Much of the published retirement research is fairly technical by nature and is somewhat inaccessible to nonspecialist audiences. This article provides a nontechnical overview of this research. In contrast to other reviews of the retirement literature, this exposition emphasizes the basic ideas and reasoning that economists use in their research. In the course of recounting how economists' views about retirement have evolved in recent years, the article highlights landmark pieces of research, points out the specific advances made by the various researchers, and assesses what has been learned along the way.

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Since the 1970's there has been a considerable resurgence of interest among economists in the study of older workers' labor supply and retirement issues. Much of the impetus for this research has been generated by public concern about a set of issues surrounding the aging of American society that will occur over the next several decades. These issues include the probable impact of an aging workforce on American productivity and living standards, the continued financial soundness of Social Security and private pension plans in the face of large increases in the number of retirees, and the changes in the economy and society that will be necessitated by the demands of a larger elderly population (for example, increased demand for health services, or changes in living accommodations).

Empirical research on retirement issues has also been stimulated by the development of databases that provide much of the information needed to explore aging issues. Most prominent among these was the Social Security Administration's Retirement History Study, a 10-year study of approximately 11,000 Americans who were aged 58-63 in 1969. During the 1969-79 survey period, in which the respondents were interviewed every 2 years, most of the sample members retired, permitting researchers to collect and analyze a large amount of data on the circumstances surrounding the timing of retirement. Much of what is currently understood about the labor supply and retirment behavior of older workers derives from studies based on this very rich database.[1]

The purpose of this article is to provide a nontechnical explanation of the basic ideas that underpin economists' thinking about work and retirement decisions, and also to discuss and elaborate on the basic economic model of retirement. The plan of the article is to begin with a simple economic model of an individual's work decision, to explain the construction and logic of this model, and to show how the model can be used to make basic predictions

about factors that might plausibly affect the timing of retirement. From this starting point—which essentially describes the economic retirement models before the late 1970's—the article then explains how the model has been extended during the past two decades. The increasing sophistication and complexity of the models reflect scientific progress in which new retirement research incorporates the findings of previous efforts, the desire to incorporate more realism into the models, and the availability of improved data. The progress in economic modeling is emphasized as the contributions of various influential studies are reviewed.

The Labor Supply of Older Workers: An Overview

Before recounting the standard economic approach to the analysis of work and retirement decisions, it is helpful to point out several well-documented facts about the work activity patterns of older Americans that any sound theory of work and retirement behavior should address.

- Nearly all United States full-time workers with strong lifelong labor-force attachment retire from the labor force between the ages of 55 and 70. Chart 1 depicts the 1995 labor-force participation rates[2] for men and women in this age interval. The 1995 graphs are qualitatively similar to those for most recent years. The men's (women's) graph shows a pronounced decline in participation rates from 83.4 (62.4) percent at age 55 to 17.3 (10.7) percent at age 70. Noteworthy are the relatively large declines in participation rates at ages 62 and 65.

- If the lifelong labor-force activity patterns of specific birth cohorts of men are examined, labor-force participation rates begin to decline slowly when cohort members reach their mid-50's, and the decline accelerates as the men enter their early 60's. Chart 2 depicts the rates at which men from three different birth cohorts left the labor force between the ages of 56 and 74. Consistent with chart 1, retirement peaks at ages 62 and 65 are notable.

- Post-World War II statistics on the average age at which American men retire show a marked trend to retire at earlier ages.[3] Contributing to this trend is the diminished popularity of retirement at age 65, and increased rates of labor market exit at younger ages, with age 62 now the most popular retirement age, as shown in chart 2.

- Many men who leave *career jobs*—that is, the main full-time job held with a single employer during adulthood—subsequently work at other jobs. Ruhm (1990) reports that most household heads in the Retirement History Study (RHS) partially retired in their later years, and one-fourth of those workers who entered complete retirement from career jobs later reentered the labor market.

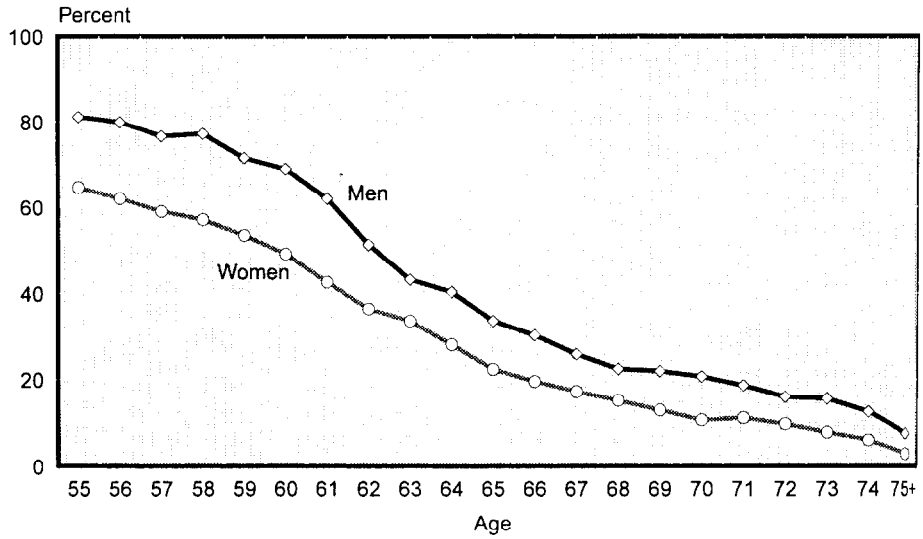
- The elderly are a very heterogeneous group. Individual responses to work and retirement incentives often vary substantially even among persons who appear to have much in common in terms of background characteristics and financial circumstances. Unobserved, unmeasured individual differences play an important role in work and retirement decisions.

In sum, a good theory of work and retirement should be able to explain these gross features of the overall retirement picture while accounting for the substantial variation in retirement decisions that occur among apparently similar individuals.

The Economics of Time Use

Conventional, or neoclassical, economics assumes that individuals make choices that maximize self-perceived well-being in light of available opportunities. That is, the supposition is that, given their circumstances, individuals attempt to do as well for themselves as possible. Of course, other social sciences such as psychology or sociology are also concerned with how individuals make such decisions. The distinguishing feature of the economic perspective is an emphasis on how options are nearly always limited by the availability of key resources—resources such as money or time. Economics focuses on how, in the face of limited resources, choices can

Chart 1.—Labor force participation rates, 1995

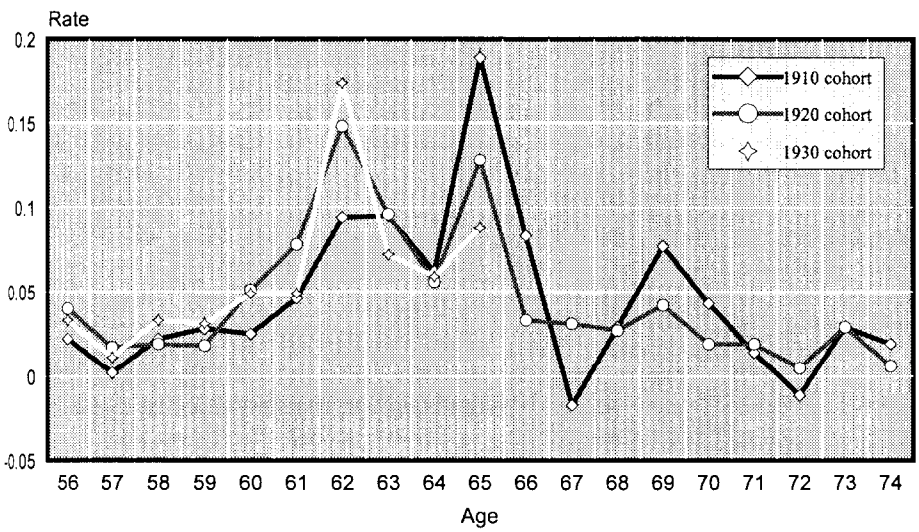


Source: Unpublished tabulations from the Current Population Survey, U.S. Department of Labor, Bureau of Labor Statistics.

be made efficiently to ensure that individuals achieve their highest attainable level of well-being. This very general formulation of the nature of economic decisions opens a wide range of behavior to economic analysis—for example, consumption, work, play, saving, household formation, educational attainment, altruism, thievery, and retirement. Economic theory also can readily account for the typical variation in the specific choices made by different individuals in that allowance is made for differing tastes and preferences among individuals. Contrary to some popular misconceptions, economics does not claim that people are primarily money oriented or that their behavior is narrowly self-interested. In fact, it is perfectly consistent with economic thinking for individuals to give money to causes they deem worthy, to work at low-paying but satisfying jobs in lieu of higher paid, albeit disagreeable, employment, or to forgo a lucrative earnings opportunity to enjoy a leisure pursuit.

One important set of economic decisions involves how people allocate their time among alternative uses. Decisions about work, retirement, leisure, and so forth, are all part of the general problem of deciding how to use time. For any particular person, the answer to this question depends on many factors that include tastes and preferences for particular uses of time (for example, what activities are enjoyable?), employment opportunities, financial needs, health, and so on. In the face of many alternative uses of time, the individual chooses which activities to pursue and how much time to devote to each. The solution to this problem emphasizes the true economic cost of pursuing any specific action, not merely out-of-pocket expenses. Assessing the economic cost entails identifying what opportunities are foregone when a particular course of action is followed, and then assigning values to these alternatives. The economic cost of an activity is the value that can be assessed to the *best* alternative that must be foregone. For example, if a person chooses to play tennis for an hour rather than read a book during the same interval, the "cost" of an hour of tennis is the value that he or she places on the pleasure that would be derived from an hour of reading.

Chart 2.—Retirement rates for men 56-74, selected cohorts



Note: For a given birth cohort, the retirement rate for age x is estimated by taking the difference in the participation rate at age x with that for age x-1, and dividing by the rate at age 55.

The Basic Model of Work-Leisure Choice

The most fundamental time-allocation decision in economics is the decision whether to work, which is the central question addressed by the *theory of work-leisure choice*. In its simplest form, the decision concerns how an individual can best allocate total available time (T) between two competing uses, the amount of time given to market work (H) and the amount of time devoted to leisure (L). That is, $T \equiv H + L$.[4] Further assume, for simplicity's sake, that the person's level of satisfaction or well-being (called *utility* by economists) depends solely on the consumption of goods (X), a unit of which can always be purchased at price P in the marketplace, and the amount of leisure that is enjoyed.[5] If income can always be earned at a wage rate of w dollars per hour worked, then the total income available to the individual during time interval T consists of total earnings (wH) plus any nonwage income (V). The individual's attainable well-being is, therefore, limited by the restriction that $XP \leq w(T - L) + V$, which is referred to as the *budget constraint*, an expression that summarizes the relationship between time and income. Given the wage rate, the amount of money that can be spent on X could vary from a minimum of V (that is, no hours are worked) to a maximum of $wT + V$, the situation in which no leisure is consumed. The cost of an hour of leisure is always w, the amount of foregone earnings.

In this simple model the individual's decision amounts to choosing how much time to work. In addition to the budget constraint, the answer depends on the person's tastes and preferences for leisure and consumption goods.[6] The solution to the problem is given by the worker's *labor supply function*, $H = H(P, w, V)$, which states mathematically that the number of hours worked depends on the price of consumption goods, the wage rate, and the amount of nonwage income available.[7] Because many people choose not to work, the case where $H = 0$ is so prevalent that the labor supply decision is often thought of as comprising two closely related stages. In the first stage—called the *labor-force participation decision*—the question concerns whether to work at all. The decision is made by comparing the real wage rate (w/P) offered by a prospective employer with the subjective value (w*) that the individual places on an hour of leisure.[8] If the real wage rate exceeds the value of an hour of leisure, then well-being is improved through labor-force participation and $H > 0$. For many individuals, however, the real wage offered by an employer provides an insufficient

incentive to work and the person opts out of the labor force. Conditional upon a decision to work, the second stage decision—called the *hours of work decision*—concerns how many hours to work. The optimum is found by selecting the number of hours for which the subjective value of an additional hour of leisure, w*, just equals the real wage rate.[9]

A typical analysis of labor supply concerns how the individual's hours of work would be likely to change in response to changes in financial circumstances and, in particular, to changes in the wage rate or income. Economic theory suggests that the effect of an increase in the wage rate on the probability of labor-force participation is positive (a higher wage increases the likelihood of working), but that the effect on hours of work for someone who already works is unclear. The latter ambiguity arises because there are two opposing incentives to consider. First, a higher wage rate effectively raises the cost of consuming an hour of leisure, that is, more income is sacrificed when an hour is not worked. This effect—called the *substitution effect*—provides an incentive to work more and to consume less leisure.[10] Second, at the new, higher wage, the original number of hours of work yields a higher income that would enable the individual to afford more consumption and leisure. Thus, the higher income could finance a reduction in hours of work through the *income effect*. In the end, whether the labor supply of workers undergoes a net increase or decrease depends on which of these two opposing incentives dominates—question that can only be answered empirically. Finally, if the wage rate is unchanged, increases in nonwage income should both reduce the probability of participating in the labor market (that is, w* increases) and reduce hours of work through an income effect.

These ideas constitute the essential features of the economic theory of work-leisure choice that serves as the basis for most labor supply research, and considerable supportive evidence has been found.[11] In the actual empirical analysis of work behavior, economists try to determine through statistical procedures specific labor supply functions that best explain the work patterns found in the economy. A statistical labor supply function can be formulated by introducing stochastic (that is, random) element ε into the hours-of-work equation. A rudimentary statistical labor supply function can thus be written as:

$$(1) \qquad H = H(P, w, V, Z, \varepsilon)$$

where Z represents a set of individual characteristics that plausibly affect the decision to work (for example, age, health, or marital status).[12] The inclusion of the random ε term explicitly recognizes that statistical labor supply models are inherently imprecise and can at best only approximate the actual decisions made by workers, especially given the limitations imposed by available data.

The statistical model described by equation (1) can be extended in numerous ways. Successful extensions include the inclusion of more alternative uses of time into decisions about time allocation; the consideration of individual choice within models of household or family behavior; the integration of saving, borrowing, taxes, and transfer payments in budget constraints; and the development of life-cycle models that incorporate multiperiod planning. These refinements augment the basic theory by incorporating more realistic features of economic life while leaving intact the essential characteristics of the simplest model.

Older Workers and Life-Cycle Models

The most basic retirement models are straightforward applications of the single-period, work-leisure choice model described by equation (1). An older person might be categorized as "retired" if he or she chooses not to work during some specified time interval—typically the reference period used in the survey that generated the research data.[13] Retirement models share many of the properties and characteristics of labor supply models for younger workers, but they generally have two distinguishing features. First, Social Security and private pension plans are institutional features that play unique and important roles in the labor market decisions of older workers and retirement models usually incorporate the relevant details. Second, the models for older workers are more likely to be cast in a life-cycle framework than are many of the labor supply models for younger, prime-aged workers. This orientation reflects the fact that workers tend to plan their eventual withdrawal from the labor force over many years. The act of retirement is, therefore, sensibly evaluated in the context of a plan that allocates time between work and leisure over the remaining lifetime.

In a life-cycle model of labor supply, the individual formulates a long-term plan for work and consumption that maximizes satisfaction or well-being over the expected lifetime. The remaining lifespan can be thought of as a sequence of N subperiods of equal finite length (for example, a year, month, week, or generally, T). A *life-cycle utility function* can be written as:

$$(2) \quad U = U(X_1, L_1, X_2, L_2, \ldots, X_N, L_N, \rho, Z)$$

where utility (U) depends on the amounts of consumption (X_t) and leisure (L_t) enjoyed in each period, on the individual's *rate of time preference* (ρ), and on Z, a vector of relevant personal characteristics that affect preferences such as gender, marital status, and health. The rate of time preference denotes the extent to which an individual prefers consumption and leisure now rather than in the future. A person with a high rate of time preference values the immediate enjoyment of a unit of consumption or leisure much more highly than their prospective enjoyment at some future date, while at the extreme of someone with no time preference ($\rho = 0$), the individual is indifferent about the timing of consumption or leisure (that is, it makes no difference whether it occurs today or sometime in the future).[14]

Current and future consumption can be financed through various income sources including earnings, savings, pensions, Social Security benefits, and other public and private transfers. The individual's objective is to plan a sequence of

consumption and work activity from now (that is, t = 0) through period N that maximizes equation (2) subject to a *life-cycle budget constraint* of the form:

$$(3)\quad \sum_{t=0}^{N} (1 + r)^{-t} P_t X_t \leq A_0 + \sum_{t=0}^{N} (1 + r)^{-t} [w_t(T - L_t) + TR_t - TX_t + PENS_t + SS_t]$$

where the new variables defined are assets held at the beginning of the first period (A_0), transfer payments (TR_t), taxes (TX_t), private pension income ($PENS_t$), and Social Security benefits (SS_t). The lifetime budget constraint simply says that the present value of remaining lifetime consumption cannot exceed the current value of assets plus the present value of all anticipated net income (earnings *plus* transfer payments *less* taxes *plus* pension income *plus* Social Security benefits). The rate of interest (r) is used to convert all future income flows to present values.[15] If the equality holds for equation (3), the individual consumes all assets and lifetime income; otherwise, unspent resources represent a bequest to heirs. The utility-maximizing desired amount of work (H_t) in each period is given by the solution to this problem and can be generally stated as:

$$(4)\quad H_t = T - L_t(P_1, P_2,...,P_N, w_1, w_2,...,w_N, A_0, TR_1, TR_2,..., TR_N, TX_1, TX_2,..., TX_N, PENS_1, PENS_2,..., PENS_N, SS_1, SS_2,...,SS_N, \rho, r, Z)$$
$$t = 1, 2, ..., N$$

The empirical work on the work and retirement decisions of older workers essentially consists of determining from data the variants of equation (4) that best explain the behavior that has been documented in specific data sets.[16]

Several features of this model should be noted. First, the estimation and empirical testing of a life-cycle model of this type require a large number of additional assumptions. A specific functional form must be selected to represent equation (4), and that choice implicitly dictates the properties of the underlying utility function (2) that describes tastes and preferences.[17] In fact, to make the problem tractable both mathematically and statistically, numerous explicit assumptions about the nature of tastes and preferences are usually made.[18] Second, the apparent simplicity of the lifetime budget constraint (3) presented here brushes aside the real-world complexity of income flows and interactions among flows. The rules that determine current and future income from various sources must be precisely specified in order to calculate the net incentives to work during each period. To cite several examples, the amount of earnings in one period can affect the value of Social Security benefits and private pension income received in another period; integrated private pension plans dictate that pension payments depend on the amount of Social Security benefits received; and both taxes paid and government transfers received depend on the level of earnings. When all tax and transfer programs are taken into account, individual budget constraints are exceedingly complicated. Third, the model as presented thus far implicitly assumes that the future is always known with certainty. In reality, all planning occurs in an uncertain environment that requires considerable personal forecasting skill. In formulating long-range plans, individuals confront uncertainties such as their own life expectancy, future health status, and the security of various sources of future income. Fourth, in order to simplify the analysis, this life-cycle model takes as given (that is, includes as conditioning elements in the Z vector) the results of other personal decisions that are codetermined with life-long work and consumption paths. Some of these items are marital status, family size and composition, education and training levels, and occupational choice.

Fifth, there are various methods by which a constrained optimization problem of this type can be solved mathematically, and the choice of solution technique depends on the details of how the problem is formally structured, which itself depends on how the model presupposes that the decision is made. For example, if the model assumes that future income streams under various desired work scenarios are known, and that there is no uncertainty with regard to health and mortality, then there is no need for any replanning to occur during the life cycle. In such a case, the utility-maximizing work and consumption plans can be generated as the solutions to an optimal control problem in which the individual knows the complete solution at the start of the first period, and then simply executes the plan as time passes. Alternatively, if uncertainty is permitted, the model might allow for replanning in which the individual revises or updates work and consumption plans for the expected remaining lifetime as more information becomes available.

Finally, economic research attempts to verify the theoretically predicted nature of the determinants of retirement and, where possible, to measure the effects of the various retirement influences. This process requires detailed information on the various factors that influence retirement decisions. No actual database contains all of the relevant information, and these shortcomings necessitate that empirical implementations omit some features of the theoretical models. Furthermore, some causal factors are notoriously difficult to measure accurately (for example, health status), while others are both unobservable and difficult to gauge (for example, motivation). Although all empirical studies involve compromises between theory and data, conclusions that are repeatedly verified with different models and different data sources attain higher levels of credibility among retirement experts.

Economic Retirement Models in Practice

This section reviews the development of economic retirement models over the past two decades. It is by no means intended to be an exhaustive survey. Rather, the idea is to sketch the development of economists' views about retirement by examining some of the most influential research.[19] The central theme is how increasingly sophisticated implementations of the work-leisure choice frame-

work have been used to explain observed retirement patterns and trends. As the models and statistical procedures have evolved, three explanatory factors have received particular scrutiny: the Social Security program, private pension plans, and health.

Early Models

Nearly all of the early modern retirement studies (*circa* the late 1970's) consisted of efforts to determine whether retirement trends for American male workers could be explained by single period work-leisure models. Up to that point, retirement was often regarded as involuntary; it was commonly thought that workers retired either because of health problems or when their employers terminated their employment.[20] The modern research introduced a decidedly different view in which retirement decisions were characterized as largely *voluntary*. The idea was that as a worker aged, eventually the subjective value of leisure might exceed the rate of compensation offered by his or her employer, and the individual would decide to withdraw from the labor force. Note that this circumstance could arise either due to an increase in the subjective value placed on leisure or to a decrease in the rate of compensation—or to some combination of the two.

In one of the earliest of the modern studies, Boskin (1977) sought to explain the long-term decline in the labor-force participation of virtually all male age-groups. In 1948, for example, the labor-force participation rate for white and nonwhite males aged 65 or older were 46.5 and 50.3 percent, respectively; by 1974 these rates had fallen to 22.5 and 21.7 percent, respectively. The study's central hypothesis was that rising income levels were associated with voluntary reductions in work (through the income effect). In particular, the expansion of the Social Security retirement program during the post-World War II period might have prompted the decline in labor-force participation among men aged 65 or older. This idea led to the development of a statistical retirement model in which the value of annual Social Security benefits for which a retiree was eligible is a key explanatory factor.[21] Boskin's model also included measures of before- and after-tax wages, nonwage income, and indicators of bad health, compulsory retirement, and presence of both a wife and children.

Boskin found that the value of current annual Social Security retirement benefits had a pronounced effect on the decision to retire (defined as working less than quarter time). A $1,000 increase in annual benefits was associated with an increase in the probability of retiring from .075 to 0.16, implying that the expected number of years of work between ages 61 and 70 falls by slightly more than a year. The effect of a $1 increase in Social Security benefit amounts is seven times as large as the effect of a like increase in income from assets. Other statistically significant factors included the level of net earnings, which had a strong negative effect on the probability of retirement, and especially the simple attainment of age 65. The results indicate that this "age 65" effect had a large influence on the propensity to retire—an effect that was very much more powerful than the effects of the Social Security program's apparent monetary incentives. This finding is consistent with both the view that Social Security might have established age 65 as a social norm for retirement, and also that the tastes of older workers shift towards leisure and away from work.

Boskin's research was one of the first attempts to consider the retirement decision as a matter of individual choice. His results demonstrated that retirement behavior is amenable to analysis using a relatively simple form of the work-leisure choice model. Particularly noteworthy is the strong role found for Social Security in this model—a result that has not been well-supported in subsequent research.[22] Note, however, that his model dictates that any work and retirement incentives associated with Social Security are allowed to influence work decisions only through the current-period income effect associated with annual benefits received. The actual structure of the Social Security program and its rules for benefit computation are not taken into account, nor is the structure of private pension plans for covered workers. The potential influence of private pensions in the retirement decision is limited to counting pension income as one component of total nonwage income for individuals already receiving benefits. Although Boskin's empirical model was influential, it is decidedly inferior to the richer structure of more recent applied work.

Pellechio (1978) also examined how Social Security affects the retirement behavior of married men aged 60-70 using a labor-force participation model.[23] In Pellechio's model the individual will work if the wage offer exceeds the subjective value placed on an hour of leisure when no market work is performed. Social Security wealth (SSW) is hypothesized to affect the subjective value of time; that is, larger amounts of wealth are thought to increase the value placed on a unit of leisure time.[24] Separate models are estimated for the 60-61, 62-64, and 65-70 age groups. The SSW variable is statistically insignificant for the 60-61 year-old group, but has significant negative effects on participation for individuals aged 62-70. When SSW increases from $35,000 to $55,000, the probability that a married man aged 62-64 will withdraw from the labor market increases by 0.15 (from 0.41 to 0.56). For persons aged 65-70, the predicted probability of retirement increases by 0.22 (from 0.78 to virtually certainty). Although this research also presents evidence of Social Security's influence on older men's work decisions, the reliability of these results is also suspect due to the lack of information on health status and private pensions.

Parsons (1980) also attempted to explain the declining male labor-force participation rates during the post-World War II era through the increased availability of income for nonworking men. Like Boskin, Parsons thought that the primary cause of the downward trend was the increased availability of nonlabor income. The Parsons model is predicated on the view that declining labor-force participation rates for United States males aged 55-64 are likely to be caused by a substitution of women's market work for men's labor-force participation within families and by a large expansion of welfare programs

that provide substantial nonlabor income. In contrast to Boskin and Pellechio, Parsons focused his attention on the Social Security disability program.[25]

Parsons' research found that nonworking men in this age group tended to have low earnings potential, as indicated by their low levels of education. Their families did not appear to have large amounts of pension, rent, dividend, or interest income, the usual sources of retirement income (that is, 13 percent of total family income for whites, 6 percent for blacks). Thus, the decline in labor-force participation was not primarily an increase in early retirement prompted by accumulated savings and assets. In contrast, welfare programs accounted for 33 and 59 percent, respectively, of total income for white and black families. Because most general welfare programs disallow aid to households headed by men who are capable of working, disability programs accounted for the bulk of the transfer income to these families (29 and 48 percent of family income for whites and blacks, respectively).

The determinants of labor-force participation in 1969 were estimated using financial variables, age, and a mortality index as explanatory variables. The key hypothesized explanatory factors were: 1) the ratio of potential monthly Social Security disability benefits to monthly wages, 2) an index of local welfare generosity normalized by the monthly wage, 3) the fraction of the year unemployed in 1966, 4) the interaction of factor (1) with a mortality index, and 5) the interaction of factor (2) with a mortality index. All of these factors, and especially the two interaction terms, were found to be significant predictors, suggesting that persons with health problems are especially sensitive to the availability of sources of income support that permit withdrawal from the labor market. Parsons concluded that the falling labor-force participation rate for older men was explained largely by the increased generosity of welfare transfers, especially Social Security disability payments. Low-wage workers were particularly affected. These conclusions have been subsequently disputed by Haveman and Wolfe (1984).

Of course, health status and financial incentives are probably only part of any comprehensive explanation of declining labor-force participation among older men. Older workers' labor supply decisions are also likely to be influenced by the nature and requirements of available jobs, factors examined in research by Joseph Quinn. Quinn (1977) investigated the relative impact of three sets of factors in explaining older men's labor-force participation decisions: 1) personal and financial characteristics, 2) local labor market conditions, and 3) job attributes.[26] Quinn's labor-force participation model also included measures of health status, indicators of current eligibility for Social Security and private pension benefits, both the husband's and wife's hourly wage rates, the amount of asset income (from rents, interest, and dividends), the presence of dependents, the local unemployment rate, the most recent annual rate of local employment growth, and indicators of three job characteristics (low job autonomy, physical or mental strain, and bad physical working conditions). Quinn found that the health variable was the single most influential determinant, lowering the probability of participating by 0.2 (from a mean of 0.9). Eligibility for Social Security and pension benefits made work less likely, as did higher income from assets. An important contribution of Quinn's study was the finding that the influence of financial incentives varies by health status. The effect of Social Security is eight times as large for those with poor health; private pension and asset income effects are three times as large. Both health and the availability of financial support are important influences in the early retirement decision, but persons in poor health are more likely to respond to financial incentives to retire—a finding consistent with Parsons' conclusion regarding disability benefits.

Quinn (1978) further explored the importance of the nonmonetary nature of the job in men's decisions to retire early (that is, before age 65).[27] Again, the central idea was that, other things equal, people tend to retire earlier from jobs with undesirable attributes. The seven job characteristics used in this analysis were: whether the worker was engaged in the whole production activity, repetitiveness of tasks, specificity of instructions for completing tasks, stress, strength, the physical nature of work, and the existence of bad working conditions. The first of these is a favorable characteristic; the last six are undesirable. There was clear support for the view that people with bad jobs are more likely to retire. Similar analysis for groups of men categorized by health status revealed those with bad health were more sensitive to characteristics of bad jobs. Individuals with poor health, especially those who were eligible for Social Security retirement benefits, were consistently more sensitive to job characteristics.

Nearly all the early retirement research addressed the behavior of men. Hanoch and Honig (1983), however, conducted a study of the determinants of labor-supply behavior of unmarried women as well as older married men, aged 58-69 in 1969-75.[28] The determinants of labor-force participation for married men and unmarried women were found to be remarkably similar. Age and health limitations had substantial negative effects on the probability of working. Social Security's primary insurance amount (PIA) value had a negative effect, particularly for women, and the effects of this income source were larger than for other nonwage income.[29] Other variables such as education, private pension coverage, and a time trend had statistically significant predicted influences. Hanoch and Honig found that once the decision whether to participate in the labor force was made, wage opportunities had surprisingly modest effects on the number of hours worked.[30] Social Security PIA values had no statistically significant effect on the hours worked for either gender. Hanoch and Honig concluded that economic variables explain surprisingly little of the labor-supply decision of older men and older unmarried women. Instead, age, perhaps through sociological and biological factors, appeared to be the single most important determinant of work activity.

In the Retirement History Study (1969-79) data, over half of all men eligible for Social Security retirement

benefits retired before the Social Security normal retirement age of 65. In contrast to previous researchers who had treated the retirement decision as a single-period choice problem, Burkhauser (1980) implemented a more explicit life-cycle approach in estimating a model of early retirement (the acceptance of Social Security benefits at age 62). Burkhauser speculated that workers determined the present value of Social Security benefits and foregone market earnings associated with retirement at age 62, and then considered how the present value of private pensions and Social Security benefits would change if retirement was postponed.

In the statistical model, Burkhauser hypothesized that early retirement is positively related to the asset value of Social Security entitlements and the probability of an early private pension; it is negatively related to market earnings, later private pension eligibility, education, and marriage.[31] Evaluated at the mean values of the model's explanatory variables, a 10-percent increase in the asset value of Social Security increases the probability of retirement at age 62 by 0.03 (from 0.21). Unfortunately, there was no information on health status available in Burkhauser's data set, so the statistical model lacks any health indicator. Other research, such as that by Quinn (1977) and Boskin and Hurd (1978), suggests that this is a serious omission in a model of the early retirement decision. Nonetheless, these results are consistent with a life-cycle theory of work-leisure choice and imply that Social Security induces early retirement.

Gordon and Blinder (1980) were also among the first researchers to examine retirement decisions within the work-leisure framework. The main contribution of their research was to estimate a *structural* retirement model. Previous empirical studies of retirement had estimated *reduced-form* equations for labor-force participation or for the act of retiring (variously defined). In the reduced-form approach, economic theory suggests which explanatory factors are likely to influence labor supply or retirement and might also provide some indication about the type and form of statistical model to select. The resulting statistical model essentially confirms and measures the influence of the explanatory factors thought to be associated with the outcome. The reduced-form model is usually neither directly nor uniquely linked to the researcher's theoretical model.[32] In fact, it is often consistent with various similar yet distinct underlying theoretical specifications. An estimated reduced-form model can be subsequently used to explain or predict changes in outcomes likely to be associated with hypothetical changes in the specific explanatory factors included in the model. A limitation of this approach is that the impact of factors not explicitly included in the reduced-form model can be estimated only if the omitted factors can be believed to affect behavior in a manner equivalent to some included factor, in which case the equivalent influence is calculated. Thus, it is usually difficult, if not impossible, to use estimated reduced-form models to predict the consequences of altering many specific features of private pension programs or Social Security that plausibly would influence behavior.[33]

The defining nature of a structural model is that the underlying preferences believed to have generated the observed behavior are specified and estimated. The advantage of the structural modeling approach is that once a mathematical representation of preferences has been determined, it is then possible to predict the response to a considerably larger variety of changes in the individual's opportunities than in the case of reduced-form models. That is, once individual preferences (that is, the utility function) are known, then it is possible to predict how behavior will respond to changed opportunities.[34] It is only through developing increasingly detailed and realistic structural models that one can determine the influence of plausible factors such as the specific features of the Social Security system, the structure of private pension plans, and so forth. The Gordon-Blinder model demonstrated how a structural modeling approach could be used to understand retirement behavior.

Gordon and Blinder's model integrates the effects of health, declining wage offers as workers age, Social Security retired-worker benefits, private pensions, and changing preferences on the retirement decision using a labor-force participation framework with two structural equations, a marginal rate of substitution function and a market wage equation.[35] Preferences, as represented by a utility function, were hypothesized to shift in favor of leisure as the person ages, generating an explicit marginal rate of substitution function (see note 8) that depends on age, health, Social Security wealth (as a ratio to full income),[36] pension availability, blue-collar work status, education, an indicator of birth cohort, and the present value of lifetime potential earnings.[37] The market wage equation contained measures of experience, job tenure, occupational group (broadly defined), age, health, education, a pension coverage indicator, and an indicator of birth cohort. Market wage offers were expressed (in logarithmic form) as hourly wage rates in terms of 1969 dollars. The work-retirement decision hinges on whether the market wage exceeds the value placed on an hour of leisure (given by the marginal rate of substitution function) when there is no labor-force participation. Note that many of the plausible explanatory variables affect the decision to retire through both structural relationships.

The results indicated that pensions play a substantial role in workers' hourly compensation offers; each $1 that an employer contributes to an employee's pension plan was estimated to be equivalent to approximately $0.52 in direct monetary compensation. Real wages were observed to decline with age, with poor health having a large negative impact on wage offers. Social Security wealth had no discernible impact on retirement prior to age 62, and afterwards had a statistically significant, but small, effect. Age apparently played an important role in the retirement decision by simultaneously lowering market wage offers and increasing the value placed on leisure. Private pensions appeared to provide strong incentives to retire at the onset of eligibility; Social Security's effects were very much weaker, and were judged not to have contributed significantly to the trend toward earlier retirement.

In its early estimation of a structural life-cycle model of the retirement decision, the Gordon-Blinder article was an influential contribution in the evolution of the retirement literature, even though subsequent research has raised concerns about the reliability of the specific findings. The decision to retire at a given age should probably be cast in terms of the relative rewards to another year of work. The Gordon-Blinder model uses net present values of income streams as explanatory variables in a current period, labor-force participation model, a formulation that weakens the life-cycle nature of the retirement decision. It would be preferable to include the *change* in the present value of income streams associated with working another year.

Retirement research in the 1970's and early 1980's was not limited to the United States. Zabalza, Pissarides, and Barton (1980) investigated the determinants of retirement decisions in Great Britain in the late 1970's, confirming that the work-leisure model could explain retirement patterns outside the United States.[38] Similar in approach to United States-based research, Zabalza, and others modeled labor-force participation as a function of income and personal characteristics. The individual's net income position—inclusive of taxes, pensions, and British social security payments—was calculated for each of three possible levels of work: full-time work, part-time work, and complete retirement. Personal characteristics included in the model were health status, age, an indicator of whether a person was old enough to receive social security payments, indicators of a "waiting wife," marital status, a working spouse, and the involuntary loss of main job.[39] Women were found to be more responsive to financial incentives than were men. Old age and poor health were strong indicators of retirement. There was also evidence of a discrete shift in preferences for leisure at the normal retirement age for both sexes.

More Recent Research

As the study of older workers' labor supply has proceeded, models have become increasingly dynamic and structural. The early models were usually *static*—in contrast to *dynamic*—in the sense that labor-force status was determined by a set of causal factors, but there was no allowance within the model for how either the causal factors or the outcome might change over time. In contrast, *dynamic models* explain the timing of a change in labor-force status. These types of models usually allow at least some of the model's explanatory factors to change as time passes, and the sequencing and timing of events is held to be critical to the behavior being investigated. Retirement is naturally considered within a dynamic model, where the focus is on the timing of a change in labor market status rather than simply on work status during some reference period.

As shown in the Gordon-Blinder (1980) study and subsequent research, structural models offer the advantage that they can potentially incorporate much of the detail of individuals' life-cycle budget constraints. These types of models allow economists to measure the specific effects of numerous features of Social Security and pension plans rather than restricting their financial incentives to operate through one or two summary measures, such as a monthly benefit amount or a coverage indicator. In the end, the main obstacle to the structural approach is the extent to which relevant information is included in the database used to support the investigation.

To illustrate with a specific problem, the early research on the effects of Social Security on retirement decisions tended to use simple program measures such as benefits amounts or Social Security wealth to ascertain the effect of the program. In fact, a complex program such as Social Security generates a complicated pattern of substitution and income effects through various program features that affect the individual at different ages (for example, payroll taxes, the retirement test, the delayed retirement credit (DRC)), and the net effect on work incentives over the life cycle is often theoretically ambiguous and can be determined only through careful empirical investigation.

To elaborate further, consider the complicated way that Social Security can influence work and retirement decisions over the life cycle. For those workers who will be fully insured by the age of retirement, the potential monthly benefit amount can influence the timing of retirement in several ways. Other things equal, the income effect of increased benefit levels would be expected to promote earlier retirement dates, decrease the likelihood of working among retirees, and to reduce hours of work by labor-force participants.[40] Note, though, that the age at which benefits are first received itself affects the monthly benefit amount via three separate channels. First, at any time during ages of 62-70, the monthly benefit rises when benefit receipt is postponed. During ages of 62-64, early retirement is penalized by reducing the monthly benefit amount by 5/9ths of 1 percent for each month the person is under age 65. The DRC increases monthly benefits when benefit receipt is postponed between ages 65-70. Second, as long as annual earnings are greater than the smallest value included in the computation years for determining Average Indexed Monthly Earnings (AIME), postponing retirement will increase the primary insurance amount (PIA).[41] Third, for some individuals a delay in retirement can result in the worker accumulating the minimum number of quarters of covered employment to qualify for retirement benefits. In all three instances the delay in retirement increases the monthly benefit amounts which, other things being equal, will lower the probability of labor-force participation. Therefore, there is a two-way relationship between work and benefit amount; each affects the other. In addition to benefit amounts, two other features of the Social Security system might influence work decisions. The payroll tax decreases the marginal after-tax wage rate for covered workers with annual earnings less than the taxable maximum.[42] Because the resulting work incentives associated with the income and substitution effects work in opposite directions, the net effect of the payroll tax is theoretically ambiguous. For those workers with annual earnings above the taxable maximum, the marginal net wage is not altered and the tax produces an income effect

that encourages work; that is, the payroll taxes paid on the earnings below the taxable maximum reduce disposable income and lower the capacity to afford leisure. Finally, the earnings test for beneficiaries aged 62-69 operates similarly to a tax on earnings when workers earn more than the annual earnings limit.[43] As long as some benefits are received, the earnings test reduces the marginal net wage and produces both income and price effects with opposing effects on work incentives. When all benefits are lost because of the test, the loss of income should stimulate work effort through a pure income effect. In sum, this type of complexity can be addressed only with a structural retirement model. The Retirement History Study (RHS), with its inclusion of administrative data on survey respondents provided by the Social Security Administration, provides much of the detail required for a thorough examination of Social Security program incentives. This feature of the database probably accounts for its continued use by retirement researchers despite the fact that most of the data were collected two decades ago.

In order to examine the financial incentives of Social Security and private pensions, Fields and Mitchell (1984) developed a structural life-cycle retirement model that examined how monetary incentives affect the age of retirement (defined as leaving the principal employer and accepting a pension). They used two complementary databases, the RHS—a source with good information about Social Security benefits, but little information about pensions—and the United States Department of Labor's 1978 Benefit Amounts Survey—a source with excellent pension data but little information about Social Security benefits. Their model assumes that individuals maximize lifetime utility by selecting a consumption path and retirement age subject to a lifetime income constraint. This constraint has as its main components the expected level of earnings at each age, and the streams of anticipated private pension and Social Security benefits contingent on retirement at each age. In choosing a retirement age, individuals weigh the monetary advantage to be gained by postponing retirement another year against the value of foregone retirement leisure.

Fields and Mitchell constructed lifetime budget constraints for the individuals in their database.[44] The critical explanatory factors were the present value of total expected income if retirement occurs at age 60 (YBASE), and the change in present value of expected income if retirement were postponed until age 65 or age 68 (YSLOPE65 and YSLOPE68, respectively). Components of YBASE, YSLOPE65, and YSLOPE68 were included as separate explanatory factors in several variants of their model. The results show that people with greater base period wealth retire earlier, and that the greater the monetary gain to delaying retirement, the later the retirement age, other things being equal. The size of the effects of monetary incentives on the timing of retirement, while in accord with theoretical predictions, are modest. For example, in one variant of their model, a $1,000 increase in the present value of income from delaying retirement is associated with a 0.03 to 0.05 year increase in age of retirement; a 10-percent increase in retirement benefits lowers theretirement age by about 1 month, on average. Results were robust across specifications. An important feature of the Fields-Mitchell model is that it assumes that all changes in income streams, including Social Security, are fully anticipated by workers.

Gustman and Steinmeier (1985, 1986) also estimated a structural life-cycle model of retirement in which preferences for income and leisure gradually shift in favor of leisure as individuals age. An important novelty offered in their work is an explicit treatment of the empirically important phenomenon of partial retirement, where some workers work part time at reduced wage rates between full-time, career work and complete retirement.[45] The empirical model assumes that individuals develop optimal work plans over the period from age 25 to 85.[46] The model allows preferences to vary both across individuals and over time with age, health, and by cohort. The pension component of compensation is the estimated change in present value associated with working an additional year; the value of Social Security is the change in accrued value from working an additional year. The individual chooses a lifetime leisure-consumption path in which the person works full time, is partially retired, or is completely retired during each period.

The results indicate that the effect of age on preferences appears to be the dominant influence on the retirement decision, although preferences for leisure exhibit a high degree of variation across individuals. In a number of simulations, Social Security and private pension provisions accounted for the peaks in the distribution of retirement ages at 62 and 65. Because of the detailed structure of their model, Gustman and Steinmeier were also able to simulate the effects of changes in specific features of the Social Security program. For example, increasing the retirement age to 67 and increasing the delayed retirement credit to 8 percent reduced the propensity to retire at 65 and increased the number of persons working full time at ages 65 and 66. Lowering the retirement test penalty rate from 0.5 to 0.33—a reform that actually took place in 1990 for beneficiaries aged 65-69—was predicted to lead to fewer retirements at age 65, and an increase in the number of full-time workers thereafter.

The Gustman-Steinmeier retirement research is an impressive blend of theory and application. Their approach imposes substantial structure on the model at the outset and, as in the case of the Fields-Mitchell research, assumes that all changes in potential income streams from various sources are foreseen that the large real increases in Social Security benefits that occurred during the early 1970's could have been anticipated by many beneficiaries. In light of subsequent research on the role of private pensions, the lack of pension plan details for covered workers in the RHS database also raises questions about the extent to which inaccuracies are introduced into this analysis through the use of imputed pension plan information for covered workers.

A third dynamic life-cycle model by Burtless and Moffitt (1984, 1985) estimated the effects of Social Security on the

work-retirement choices of the elderly. Their model assumes that decisions about retirement date and post-retirement hours of work are made jointly.[47] As in the case of the Gustman-Steinmeier model, a critical feature of the model's structure is that individuals are assumed to have preferences that shift in favor of leisure as they grow older. Prior to retirement, utility is hypothesized to be (linearly) dependent on hours worked, the preretirement hourly wage, and socioeconomic characteristics (for example, health, age, race, education, or private-pension vesting). Utility declines with age until the negative contribution of the age term becomes sufficiently large that the person is better off retiring. Postretirement utility is a nonlinear (that is, logarithmic) function of consumption, hours of work, education, and marital status. The model's structure also dictates that only one type of labor supply adjustment is permitted per person: work to partial retirement, or work to complete retirement. Although the RHS database lacks the requisite detail to ascertain the specific role played by private pensions, the authors reported that Social Security influenced both retirement age and choice of post-retirement hours of work, but the magnitude of the effect on the age of retirement was small. Estimated magnitudes were generally consistent with those reported by Fields-Mitchell and Gustman-Steinmeier.

If individuals are the long-term planners described in life-cycle labor supply models, saving behavior would likely be an important related phenomenon. Accordingly, Diamond and Hausman (1984a) examined the effects of Social Security and private pensions on both retirement (stopping full-time work) and saving decisions.[48] Life-cycle theory suggests that a rise in future resources, perhaps due to an increase in Social Security benefits, will lead to increased consumption in all periods, including the present. In fact, this might not happen for two reasons. First, individuals might not be able to convert the additional wealth into current consumption. Second, people might be backward- rather than forward-looking when making their consumption decisions. For instance, current consumption could be strongly influenced by persistent habit.

In the Diamond-Hausman model, both pensions and Social Security were shown to have strong positive effects on the probability of retirement, as did permanent income and bad health. The onset of a health problem had the same measured impact as an increase in yearly pension income of about $1,600. Social Security had a positive effect on early retirement, but its effects were dominated by the other explanatory factors. The conclusion was that even without Social Security, the trend to earlier retirement observed in the data would have likely occurred. In the analysis of savings and wealth accumulation, higher pensions and Social Security led to decreased personal savings; a $1 increase in Social Security benefits received per year was associated with a $0.25 to $0.40 decline in other personal savings. Therefore, Social Security appears to have had a significant effect on retirement decisions, both directly through the provision of income and indirectly through its effect on savings. Numerous studies have underscored the key role of health in the decision to work. Hausman and Wise (1985) measured the importance of both health and Social Security wealth on the retirement decision (persons are retired if they claim to be either completely or partially retired).[49] The graph of the hazard by age computed for the RHS sample shows that the hazard rises to a peak at ages 63-64, declines slightly at age 65, and is relatively constant thereafter.[50] The Hausman-Wise model examined the influence of monthly Social Security payments (and their change if retirement is delayed another year), Social Security wealth (and its change if retirement is delayed another year), earnings, the value of liquid assets, education, the number of completely supported children, age, indicators of bad health and private pension eligibility. After age 62, larger Social Security payments were associated with a higher probability of retirement, and greater monthly rewards for working made retirement less likely (that is, there was a dominant substitution effect associated with the increased wage rate). Between ages 62 and 64, poor health had the equivalent effect of a $10,000 increase in Social Security wealth. Most variables had their predicted effects, except for the pension indicator, which was statistically insignificant. The results suggest a substantial effect of Social Security benefits on the probability of retiring. Benefit increases in the 1969-75 period probably accounted for a 3-5 percentage point increase in the probability of retirement for men aged 62-66.

Sickles and Taubman (1986) considered a more complex relationship between health and retirement, and explored how financial factors such as Social Security benefit amounts might influence both (retirement was defined as not working full time). Retirement and health status equations were jointly estimated using panel data.[51] Explanatory variables in the retirement equation included age, race, marital status, number of dependents, job type, various income sources, the estimated financial gain from postponing retirement, and health. Health status was assumed to influence retirement, but the model did not permit retirement status to affect health. The key income variable in the retirement equation was the monetary gain from postponing retirement. A transition from good to poor health increased the probability of retirement by 0.21. Social Security and pension payments, however, had positive effects on health that partially offset their direct influence on retirement. There was a large amount of individual variation in both the retirement and health equations. The authors concluded that an effective way to increase work among the elderly would be to raise the age at which early retirement benefits are paid.

Although life-cycle models have usually assumed perfect foresight and information, some analysts have explicitly addressed the importance of uncertainty in the timing of retirement. Diamond and Hausman (1984b) investigated the impact of two common sources of uncertainty: the onset of poor health and involuntary unemployment.[52] Their research modeled the probability of retirement (an individual describes him- or herself as retired or unable to work) as dependent on both personal characteris-

tics and financial variables. The estimated model indicated that both private pensions and Social Security had strong positive effects on the probability of retirement. Larger permanent incomes were associated with a somewhat lower probability of retirement—an anomalous finding that is contrary to what theory would lead one to predict. Health also played a key role, especially in the decision to retire early. The onset of poor health was equivalent in its effect on retirement to a $540 monthly increase in pension entitlement.

The analysis also considered the response of older workers to involuntary unemployment. In the National Longitudinal Survey data, 36 percent of men aged 60-64 whose employment was terminated subsequently retired instead of moving to another job. Higher levels of pension income, Social Security benefits, poor health, age, wealth, and a wife's (permanent) income level were positive influences on the decision to retire after losing a job. Both private pensions and Social Security retirement benefits had strong positive effects on the probability of retirement, with the effect of Social Security especially strong at age 62.

Although the preponderance of evidence has identified the Social Security program as a significant factor in American retirement patterns, empirical results have been somewhat mixed about the extent to which Social Security has contributed to the marked trend to earlier retirement in recent decades. In another effort to incorporate the role of uncertainty into the analysis, Burtless (1986) developed a life-cycle model in which predictable benefit increases are distinguished from unanticipated changes.[53] Between 1969 and 1972, there was a 20-percent increase in the real value of Social Security retirement benefits—an increase that followed a 15-year period in which the level of real Social Security benefits for a worker with a specific earnings history was approximately unchanged. It is unlikely that this sudden, sizeable increase was anticipated by beneficiaries.

Burtless' research confirmed that retirement is a function of health, marital status, household size, and financial variables from the budget constraint.[54] Poor health, household size, an indicator of wealth in excess of $25,000, and total family wealth in 1969 all lowered the age of retirement; lower levels of wealth, being married, and the rate at which family wealth accrues when retirement is delayed for 1 year (that is, the slope of the lifetime budget constraint) are positive influences on retirement age. Men who reported bad health retired about 1.1 years earlier on average. Evaluated at sample mean values, the implicit rate of time preference of retirees appeared to be slightly greater than 5.0 percent. The estimated model was used to calculate the effects of the presumably unanticipated benefit increases in 1970 and 1972. Burtless estimated that the average retirement age was about 0.09 years (4.7 weeks) earlier due to these unanticipated increases; had these changes been anticipated, the long-run effect would have been to reduce the average retirement age by 0.17 years (8.8 weeks). The estimated magnitudes in this article are consistent with those studies that have found that changes in Social Security benefit levels have a modest effect on the timing of retirement.

Sueyoshi (1989) attempted to identify and measure factors that determined the timing of retirement during the 1970's, as well as whether initial labor-force transitions were to partial or complete retirement. Transitions to partial retirement are empirically important; approximately one-third of the RHS sample claimed to be partially retired at some point during the 10-year survey period. The mean duration of the partial retirement state was estimated to be 5.5 years, with a median of about 20 hours of work per week reported among partial retirees. Graphs of the simple hazards for the two types of retirements showed that the "risk" of (probability of first entering) partial retirement remained roughly constant with age, but the risk of complete retirement increased sharply at age 65.

Sueyoshi's model permitted the competing risks of partial and complete retirement to be analyzed together and allowed for potential correlation between the two risks. The variables used in the analysis controlled for individual differences as well as economic factors.[55] Social Security was found to decrease the labor-market activity of older workers. The probability of complete retirement increased as the benefit amounts available at age 62 increased; however, there was little impact of benefit levels on the likelihood of partial retirement. Increasing the rate at which an individual's benefit amount rises when retirement is delayed between age 62 and 65 had little effect on the decision to retire completely, but lowered the probability of partial retirement. Thus, Sueyoshi's findings lead to the somewhat surprising conclusion that policies that increase benefit levels and increase the amount by which benefits increase when retirement is postponed between ages 62 and 65 will probably prompt people who might otherwise partially retire to retire fully.

The most technically ambitious approach to retirement modeling has been described in a series of articles by Rust (1989, 1990), and Phelan and Rust (1991). Nearly all retirement models have assumed that individuals accurately foresee income-consumption possibilities under alternative work scenarios and make lifetime work plans that are subsequently carried out without change. In view of the pervasive uncertainty that attaches to future events, a more realistic approach would allow individuals the opportunity to update and revise their plans as new information becomes available. In Rust's model, individuals formulate and routinely revise a utility-maximizing plan for work and consumption over their remaining lives. Planning must be based on expectations about longevity, health, marital status, income, and wealth—all of which are determinants of retirement whose future values cannot be known with certainty when long-term plans are formulated. A key innovation of Rust's model is its elaborate modeling of the formation and revision of these expectations. The full model simultaneously explains employment status, consumption expenditures, and the timing of the first application for Social Security benefits. As individuals age and acquire additional information, they can update consumption

and work plans to reflect changed circumstances (for example, the onset of a disabling health condition). Rust's treatment of these decisions as a dynamic stochastic programming model is fully structural; individual utility functions are estimated and then used to examine the impact of life-cycle budget constraints.[56]

In reporting preliminary estimates of the utility function parameters from their model, Phelan and Rust (1991) note that the model predicts the timing of retirement from full-time employment by higher paid workers quite well, but is somewhat less successful for lower wage and part-time workers. The model's predictions capture the popularity of first receipt of Social Security retired-worker benefits at age 62, but they underestimate the frequency with which benefits are first collected at age 65. Anomalies are also noted regarding the predicted behavior of workers with health impairments; the model overestimates their propensity to work. The authors observe that expanding the model's capability to address disability issues and the demand for insurance under Medicare is a promising extension that might improve its predictive power in several of these areas.

The dynamic programming approach has also been used by Berkovec and Stern (1991) in a model that explains how older men choose among the alternatives of full-time employment, part-time employment, and complete retirement.[57] Individuals are assumed to maximize utility when they make decisions about employment at the beginning of each period. The decision is based on observed values of monetary payments and leisure associated with each employment state in the current period, as well as expected values of these variables in future periods contingent on current and past choices. Poor health, age, and lack of education are shown to increase the probability of retirement. The major weaknesses of the empirical work are that it assumes that a number of magnitudes (for example, future health status) are known with certainty, and the potential influence of the Social Security system is not considered. The primary contribution of this paper is methodological; it demonstrates how the method of simulated moments can be used to estimate a dynamic work-retirement model with a complex error structure.

Dynamic programming retirement models can potentially incorporate enormous amounts of detail about lifetime budget constraints and, given the power of modern computers, are limited only by data availability and the ingenuity and diligence of researchers. This approach clearly assumes substantial rationality on the part of individuals and a predilection for carrying out long-term plans. As pointed out by Phelan and Rust (1991), two of the leading contributors to this literature, it is uncertain in what direction this approach will eventually evolve. One option would be the development of increasingly detailed optimizing models where observed behavior is explained by a level of mathematical complexity understood in reality by only a tiny fraction of the population. Although many successful behavioral models involve computational processes that relatively few individuals can actually perform, one can be rightfully skeptical if it is hard to see how individuals can approximate the results of sophisticated analysis by trial-and-error methods or by employing rules of thumb. Alternatively, dynamic programming models might eventually give way to other types of models that attempt to mimic real human decision processes. One might reasonably expect that researchers will opt for whatever approach best explains the observed variation in labor supply and retirement behavior. For now, it is interesting that in one attempt to compare the predictive power of simpler empirical retirement models with that of a dynamic programming model, Lumsdaine, Stock, and Wise (1990a) found that a simpler option value approach performed about as well as the more complex model—although it must be emphasized that the dynamic programming model that they tested has nowhere near the complexity of Rust's model.[58]

Most of the economic retirement research conducted since the late 1970's has used data from the RHS. The RHS's inclusion of the Social Security Administration's information on respondents' lifetime earnings and benefits in good part accounts for the intensive efforts by researchers to determine the effects of Social Security on American retirement behavior. The consensus of this research has been that Social Security's program features have statistically significant, but relatively modest, effects on the overall retirement picture. Behavioral estimates from the best quality studies suggest that Social Security probably has caused the average age of retirement for men to decline by several months. Social Security probably accounts for the current popularity of retirement at age 62, primarily by helping to supply the wherewithal for workers with few assets, undesirable jobs, or poor health to leave the labor force when early retirement benefits are first available. Unfortunately, an increasingly evident shortcoming of the database is its minimal information about private pension plans for the RHS respondents. This aspect of the database severely limits any RHS-based investigation of the effects of pensions on the timing of retirement for covered workers. Recent studies using other data sources have identified the important role played by pensions and have sought to determine how the structure of private pensions influences retirement.

Private pensions are a key source of retirement income for a significant portion of the population and, in their function of providing a means of financing consumption during retirement years, they would, at first blush, appear to encourage retirement and deter work via their income effect. This is particularly the case with respect to *defined contribution* plans in which retirement savings accumulate as the employer makes periodic payments to a worker's retirement account as specified by a formula. In these plans, pension wealth eventually depends on the returns on the retirement account's assets as well as on the employer's contributions.

More complex are the incentives for work and retirement posed by *defined benefit* pension plans, which constitute the predominant primary pension plan type for workers who are covered by private pensions. As pointed out by

Kotlikoff and Wise (1987), defined benefit plans are usually structured in ways to motivate employees to behave consistently with the firm's personnel goals. Specifically, firms usually aim to discourage quitting among experienced, skilled workers, particularly those who have received costly training; they seek to promote worker effort on the job while discouraging shirking; and they often want older, higher paid workers to retire so that high-priced labor can be replaced by younger, lower paid workers. All of these objectives can be advanced by establishing a career compensation profile that rises with job tenure until workers reach the firm's chosen retirement age, after which the rate of compensation levels off or declines. One way to achieve this compensation payment schedule is through defined benefit pensions. The pension component of total compensation is actually deferred compensation—payments that will be received only at the end of the worker's career. Early departure from the firm, both voluntary and involuntary, is discouraged because both vesting rules and nonportability of benefits mean that early departure can impose large capital losses on workers. Because pension amounts eventually paid by defined benefit plans depend on a worker's highest earnings (typically received late in the career) and the number of years of employment with the firm, the annual accumulation of pension wealth represents a significant component of total compensation for older workers. Gustman and Steinmeier (1989) estimate that the annual increment to pension wealth amounts to 15-16 percent of total compensation for workers during the several years prior to the typical employer's early and normal retirement ages. To encourage older workers to retire at the firm's preferred age, the employer can offer extra monetary incentives in the form of retirement bonuses to workers who leave the firm at that age. When pension receipt is conditional on full retirement from the firm, workers who remain with the employer past the firm's normal retirement age often experience negative pension wealth accruals as the present value of increments to anticipated future benefits is less than the value of pension payments currently foregone. This type of pension structure means that the older worker effectively faces a large decrease in annual total compensation for working past the normal retirement age, providing a strong incentive for workers to leave the firm.[59]

Although earlier empirical work (for example, Burkhauser (1979), Fields and Mitchell (1984)) explicitly modeled the effects of pension wealth accrual on the timing of retirement, more recent research has provided stronger evidence on the importance of pensions for covered workers by incorporating a conceptual innovation offered by Lazear and Moore (1988). The earlier studies that attempted to include measures of pension wealth accrual as a component of a worker's total annual compensation would simply include the difference in the net present value of the anticipated stream of future pension payments associated with another year of work. Measures of annual pension wealth accrual can then be incorporated in an individual's budget constraint. This procedure, however, does not generally provide an effective indicator of the incentive created by a private pension plan for an individual to continue working. For example, in the year prior to the year in which cliff vesting occurs, actual pension wealth accrual might be calculated to be zero; that is, retirement that year would lead to no higher expected future pension payments than retirement in the previous year—prior to vesting, the worker has not earned a pension right.[60] In fact, private pensions provide a fairly strong incentive to remain with an employer in the year prior to vesting, since leaving at that point terminates the prospect of a future income from the firm's pension plan.

The *option value* approach to the analysis of pension incentives focuses on the notion that at any point in time the decision to continue working maintains an option to retire at a future date, and that option has value that typically changes appreciably over time. At any point in time, the present value of all expected future pension payments can be calculated assuming that the worker retired immediately. A similar calculation can be made assuming retirement at other dates in the future, discounting future income streams to the same point in time. The "option value" of continued work is the difference between the highest present value associated with retiring at any future date and the present value of retiring in the current period. The pension plan provides an incentive for continued work as long as the option value is positive. The optimal retirement date occurs at that point where the option value first falls to zero, or a negative value.

Stock and Wise (1990a, 1990b) used an option value approach to model the retirement decisions of 1,500 salesmen employed by a large, *Fortune 500* firm in 1980. In the Stock-Wise option value model, at each age the worker calculates the present value of the stream of utilities associated with expected income and leisure over the anticipated remaining lifetime if the worker were to leave the firm immediately. A similar calculation is made assuming retirement occurs at each year in the future. If the utility level is higher for a future retirement date, the individual continues to work. When the option value or gain from postponing retirement—now measured in utility units— is zero, the individual retires from the firm. Using a very parsimonious model in which the effects of Social Security must be estimated on the basis of imputed earnings histories, Stock and Wise were able to predict the retirement behavior of the sample very well. Simulations using the model suggest that the effect of changes in either Social Security's normal retirement age or the early retirement reduced benefit rate are easily offset by relatively minor changes in the private pension rules. Because the underlying data are drawn from only one employer, the results should be considered preliminary and should not be extrapolated to larger segments of the population. Nonetheless, the findings are sufficiently promising to encourage further research and represent key evidence supporting the current view that, for covered workers, defined benefit pension plans are a very important element, if not the dominant factor, in the timing of retirement.

During the 1980's many American firms reduced the size

of their workforce in reengineering efforts to increase competitiveness. Rather than resort to morale-depleting layoffs, employers often targeted older, higher paid workers with special incentives to leave the firm voluntarily. One personnel tool for accomplishing this objective is to offer a *retirement window* in the firm's pension plan. A private pension plan offers a retirement window when a group of workers is promised a specific bonus beyond the usual pension plan rules for leaving the firm within a specified time period. The window provision might take the form of a cash bonus or a temporary change in the rules for calculating pension benefits that leads to higher benefits if the worker retires by a specified date. It is common for the window to be offered only to a specific category of workers, a category that might be defined by age, seniority, occupation, division within the firm, and so forth.

Lumsdaine, Stock, and Wise (1990b) examined the effect of a window provision on the retirement behavior of a sample of 1,000 randomly selected male office workers, aged 50 or older, working for a *Fortune 500* firm in 1980.[61] The window provision offered retirement bonuses of 3 to 12 months' salary, the amount varying with age and years of service. The study uses the option-value model developed by Stock and Wise (1990b), where workers retire at the point where their perceived value of immediate retirement exceeds the expected present value of retiring at any future date. The estimated model shows a sizable effect of the window plan on retirement behavior. The proportion of employees working at age 52 who subsequently retire by age 60 increases by approximately 50 percent (that is, 0.79 percent retired, compared to the 52 percent predicted in the absence of the window). The results suggest that firms can significantly influence employee retirement decisions through the use of well-designed retirement windows.

Hogarth (1988) provided confirmatory evidence of the effectiveness of a somewhat different retirement window offered by the New York State government in 1983 in a large downsizing effort. During that spring, vested workers aged 55 or older were given an additional 3 years' service credit if they retired by May 31, 1983. In response, 30 percent of eligible employees accepted the offer. Hogarth estimated a pension-acceptance equation which included economic, sociological, and psychological factors including the present value of future earnings, health status, employment status of spouse, perceived adequacy of retirement income, and a DIFFERENCE measure of the change in value of the pension (measured in thousands of dollars) associated with retiring immediately, compared with waiting until the planned retirement date.[62] The DIFFERENCE variable was statistically significant, and raised the probability of acceptance by 0.03 above its mean of 0.30. Most variables performed in a predictable manner, with bad health and greater age increasing the probability of early retirement, and the present value of earnings decreasing the probability. A notable finding is the importance of expectation variables in the decision. An expectation of a layoff increased the probability of accepting the pension offer by 0.15, while an expectation that retirement income would not be adequate lowered the probability of acceptance by 0.06. This article provides additional evidence that retirement decisions are responsive to monetary incentives associated with additional years of work, although these effects appear to be relatively modest, consistent with the earlier findings of Burkhauser (1979) and Fields and Mitchell (1984).

Discussion and Conclusions

A substantial body of research has assessed the relative importance of financial incentives, particularly Social Security and private pensions, in the retirement decision. Financial incentives have been shown to affect retirement and work choices in a manner consistent with the theory of work-leisure choice, but they are sometimes overshadowed by noneconomic factors, particularly age and health. The secular rise in the real incomes of the elderly has helped finance earlier withdrawal from the labor force through an income effect. Convincing evidence exists establishing a link between increasingly generous Social Security benefits and reduced labor market activity of older workers over time. Social Security is probably responsible for the particular popularity of retirement at ages 62-65. As documented by Kahn (1988), workers with relatively low amounts of non-Social Security wealth who would like to retire early are probably liquidity-constrained prior to age 62, the point at which Social Security provides the means to leave the labor force. This is likely to be particularly true for workers with health problems or for those who work at unpleasant or physically demanding jobs. Social Security probably has accounted for the longtime, but declining, popularity of retirement at age 65 through the retirement test and an actuarially unfair delayed retirement credit. The continued liberalization of the retirement test and scheduled increases in the DRC lessen the impact of these provisions with time (Leonesio (1990a)).[63] Finally, it cannot be ruled out that, in its declaration of age 65 as the program's normal retirement age (that is, the first age at which full retired-worker benefits can be collected), Social Security might have given impetus to retire at that age through the establishment of a social norm.

Recent evidence indicates that older workers covered by defined benefit private pensions are likely to be strongly influenced by the structural features of those plans. Firms can create sharp incentives to continue working or to retire at specific ages through the pension wealth accrual profile. Changes in the slope of this profile are tantamount to large proportional changes in the annual rate of total compensation paid to workers. In fact, these incentives can be sufficiently powerful so that employers could easily offset the effects of most prospective changes in the Social Security program aimed at changing the Nation's retirement behavior. For example, the scheduled increase in the Social Security normal retirement age provides an incentive to work longer, but firms will have the option to adjust pension wealth accrual profiles to ensure that the timing of retirement of their older employees remains unchanged.

Further progress in retirement modeling now awaits the

development of new databases whose information content reflects the current state of knowledge. The more that has been learned about retirement, the greater the awareness of the deficiencies in the data sources that have been used in the past. The estimation of dynamic structural models requires comprehensive and detailed information about the life-cycle budget constraints that critically influence observed behavior. As this article has shown, modern retirement models consider the labor market decisions of older workers to be largely voluntary. In order to understand these choices, it is necessary to have detailed information about the various options at different points in time that were *not* chosen, as well as the circumstances attending those that were. Certainly, good, new data sources for retirement modeling will have to contain sufficient details about individual work histories to permit researchers to mimic the computations done by the Social Security Administration to calculate benefits for retirees. In addition, the database should include the specific rules that are used to determine any pension benefits for which the worker might be eligible since these are required to calculate the incentives to remain on the job or retire. The database should ideally have good information about all other potential sources of retirement income including earnings opportunities, savings, and both private and public transfers. The University of Michigan's new Health and Retirement Study (HRS) is an ambitious data collection effort that attempts to address all of these needs.

Improvements in models that exploit new data sources will enable researchers to address a number of questions that have not been satisfactorily addressed to date.

The Interaction Between Health and Retirement

Until the new HRS, no single database has contained both comprehensive information about individuals' budget constraints as well as good measures of health status and ability to work. Studies that have used self-reported measures of health status have often found health status to be more influential than financial considerations in explaining retirement. Quinn (1977) reports that health and eligibility for Social Security and private pension benefits are equally influential in the early retirement decision for white married men.[64] Gordon and Blinder (1980), Boskin and Hurd (1978), and Hanoch and Honig (1983) find that poor health increases the probability of retirement in a given year. More recent work suggests that studies that purport to show health to be more influential than financial variables in the retirement decision may have incorrectly measured both magnitudes (Anderson and Burkhauser (1985)). Bazzoli (1985) investigates how the estimated effect of health on early retirement responds to alternative measures of health status, and concludes that studies that measure health by asking individuals whether their health limits work activity overstate its true effect. Inaccurate measures of health status have probably caused the impact of health on work and retirement to be overestimated, but the amount of bias is uncertain.[65] Health status, the functional capacity to work, and closely related issues such as a family's long-term care needs, access to quality medical care, the availability of private and public insurance, and the incidence of out-of-pocket medical expenses, are clearly important considerations when older individuals make decisions about work and retirement. Real advances in this area will require new data of the type collected in the HRS, where respondents answer extensive batteries of questions on their physical and mental health status, including both objective and subjective measures (Wallace and Herzog (1995)).

Demand for Older Workers

Most studies of older workers have concentrated on the supply side of the market, leaving the demand for older workers relatively underexamined, as pointed out by Straka (1992). Older workers often complain that suitable work opportunities are limited. Many older full-time workers would prefer to continue working part time for their employer rather than retire completely, but few employers appear to offer this option. Using data from a survey of 267 work establishments conducted by the American Society of Personnel Administration and the Bureau of National Affairs, Gustman and Steinmeier (1983, 1984) report that only 10 percent of employers appear to permit full-time employees to reduce hours prior to complete retirement. Private pension plans usually require that a worker leave the firm before pension receipt can begin. Continued employment for the older worker usually entails a change in employer and a sharply reduced wage rate with few fringe benefits. The constraints that govern the individual choices examined in the retirement literature are in large part determined by employer attitudes and policies regarding older workers. Further empirical analysis of the demand for older workers would significantly enhance our understanding of observed work and retirement patterns and perhaps inform the development of appropriate public policies. Again, data limitations currently proscribe research possibilities—a situation that generally applies to the empirical study of labor demand. The ideal database would include considerable detail on firm decisions about production technologies, personnel policies, and the use of cooperant factors of production, along with considerable detail about individual employees. A large, nationally representative database of this type does not currently exist.

Research On Women's Retirement and Family Retirement Models

Most retirement research has concerned the behavior of men, with relatively few studies examining women's retirement decisions. Notable exceptions are provided by Clark, Johnson, and McDermed (1980), Pozzebon and Mitchell (1989), Hurd (1990a), Vistnes (1994) and Gustman and Steinmeier (1994). This small and uneven literature is reviewed and criticized by Weaver (1994). To date, results are inconsistent and should probably be viewed with some skepticism. The main impediment has been a lack of suitable data, especially with respect to married women. The RHS, the information source for much of the men's retirement literature, primarily collected data for men and for single women; data for married women were included mainly to illuminate the

behavior of their husbands. This is another shortcoming to be remedied by the new HRS, a database whose design recognizes the central place women now occupy in the labor market.

Married women's labor market decisions are best understood within the context of their families, where husbands and wives jointly make choices about work, consumption, and eventual retirement in light of family wants and needs. Although it has long been recognized that men's labor supply is influenced by factors such as marital status, family size, and income amounts earned by other family members, most economic models of male labor supply decisions have simply taken the labor market decisions of spouses to be independently determined events. That is, apart from counting a wife's earnings as a component of family income that is not earned by the husband, the husband's labor supply decisions have often been modeled taking the wife's current labor-force status to be an unchanging, external event.[66] This simplifying assumption—less tenable as the labor-force activity of women increasingly resembles that of men—has long been recognized as even less satisfactory when attempting to understand the labor supply of married women.

Ideally, retirement models for married men or women would take into account the complex life-cycle budget constraints that jointly influence the timing of retirement for both spouses, including Social Security's treatment of couples, private pension rights that have been earned by each spouse, and the influence of factors such as the deterioration of health of a spouse or the burden of providing home-based care to an elderly parent. Our confidence in measurements of the impact of financial incentives on work and retirement behavior will likely increase as researchers increase the scope of potentially confounding nonmonetary factors that are simultaneously evaluated.

Notes

[1] Other U.S.-based data sources frequently used in retirement research include the Department of Labor's National Longitudinal Survey of Mature Men, the University of Michigan's Panel Study of Income Dynamics, various samples selected from the Census Bureau's Current Population Surveys (CPS), the SSA New Beneficiary Survey, and the 1973 CPS-IRS-SSA Exact Match file. This last data source was created by matching CPS data with administrative data from the survey respondents' records maintained by the SSA and the Internal Revenue Service (IRS). Details concerning these and other surveys may be found in publications reporting research findings based on the specific data sources. Many of these publications are cited throughout this article. Alternatively, readers may wish to contact sponsoring agencies or institutions of each survey to learn more about them. Readers can also contact the InterUniversity Consortium of Political and Social Research at the University of Michigan, which maintains an archive of these and other databases.

[2] The *labor force* is defined as all persons (aged 16 or older) who are employed, unemployed but actively seeking work, or who are awaiting recall from a layoff. The *labor-force participation rate* is the number of individuals in the labor force divided by the population.

[3] Post-war retirement-age trends for women are not as pronounced in that there has been a very large influx of women into the labor force that has partially offset any tendency for women with strong labor-force attachment to retire at younger ages.

[4] Note that this theory uses an unconventional definition of the term *leisure*; leisure refers to all time not devoted to paid work. Of course, not all nonwork time is accurately characterized as voluntarily chosen leisure. Considerable amounts of time need to be devoted to sleeping, eating, and routine personal hygiene. Some time must be allocated to activities more accurately described as chores than as leisure. In a very influential article, Becker (1965) extended the basic work-leisure choice model by explicitly accounting for the large number of potential uses of time. In Becker's model, labor-supply decisions are made jointly with decisions about the amounts of time to devote to the many distinct activities that the simple model aggregates as "leisure."

[5] One can think of X as a hypothetical generic commodity that satisfies all consumption needs or, more realistically, as a vector (or collection) of many goods and services, units of which sell at prices given by the respective elements of conforming price vector, P.

[6] In economic models tastes and preferences are expressed mathematically by *utility functions*, which relate the level of well-being, or utility (U), to the levels of consumption and leisure enjoyed. In this example, a strictly concave utility function can be written in general functional notation as $U = U(X, L)$, where it is assumed that $\partial U/\partial X > 0$, $\partial U/\partial L > 0$, $\partial^2 U/\partial X^2 < 0$, and $\partial^2 U/\partial L^2 < 0$. These four assumptions about the properties of $U(.)$ imply that utility always increases as the amounts of consumption goods or leisure increase, but at a decreasing rate. The optimal amounts of consumption and leisure are given by the solution to the constrained optimization problem:

$$\text{Max}_{X,L}\ U = U(X, L) \text{ s.t. } XP \leq w(T - L) + V$$

[7] Economists often express theories in terms of mathematics because of the precision which these formulations permit. Once a problem has been defined, the solution can be found using appropriate mathematical techniques. Note that this methodology does not imply that people literally use formal mathematics to make their economic decisions. Rather, the argument is that through normal decision-making processes, intuition, rules of thumb, solicited advice, and the like, individuals arrive at decisions that are quite similar to those generated by economic models. Thus, people are thought to act "as if" they had arrived at their decisions through the more formal analytical methods used by economists to solve the problem. The ultimate test of the theory rests with its power to explain behavior. These ideas have been forcefully espoused by Milton Friedman (1953).

[8] The *real* wage offer, w/P, indicates the rate at which leisure can be transformed into goods. For example, if a unit of good X sells for $3 and the worker's wage rate is $12 per hour, the real wage is 4. That is, for every hour of leisure that the individual gives up by working, 4 more units of good X can be consumed. The theory is founded on the view that individuals never suffer from "money illusion." Regardless of nominal price, wage, and income levels, people are always assumed to understand precisely what real resources any particular sum of money can command.

The subjective value that the individual places on time is given by the *marginal rate of substitution function*, $w^* = w^*(X, L)$, which is given by the expression $(\partial U/\partial L)/(\partial U/\partial X)$. The decision whether to work at all depends critically on the value of w^* when $L = T$. Other things equal, w^* increases as L declines.

[9] The rationale for this result lies with the nature of the utility function (note 6). Because utility increases—but at a decreasing

rate—as more leisure is consumed, additional hours of work will always increase the subjective value of the $(T - H)^{th}$, or *marginal*, hour of leisure enjoyed. That is, the less we have of something desirable, the greater value we tend to place on each unit. If the individual works, w/P must exceed w*, the subjective value placed on the T^{th} unit of leisure. As the number of work hours increases, the subjective value of an hour of leisure will increase. Utility will be at its highest when the number of hours worked is such that the subjective value of the L^{th} hour of leisure just equals the wage. If an even greater number of hours were worked, the subjective value of leisure would exceed the wage and utility could be increased by reducing the number of hours worked.

[10] The term *substitution effect* connotes that if the price of a commodity increases, people will tend to consume less of it by substituting the consumption of now relatively cheaper commodities. Conversely, if the price falls, individuals will tend to consume more of a commodity.

[11] Good surveys are provided by Killingsworth (1983), Killingsworth and Heckman (1986), and Pencavel (1986).

[12] These factors can account for tastes and preferences that vary across individuals.

[13] It is possible to choose different definitions of *retirement*, various of which might be better suited to particular purposes. A labor-supply-oriented definition that focuses on hours of paid work has the advantage of being based on behavior that is observed and documented in many databases and, hence, is readily amenable to statistical analysis. Other common definitions of retirement include departure from a career job; a sustained, sizeable reduction in annual earnings; receipt of Social Security benefits or private pension income; or merely the self-assertion that a person is retired. See Ekerdt and Deviney (1990).

[14] A person with a high rate of time preference gives large weight to current events and highly discounts the importance or value of future events. Thus, a young worker with a very high discount rate would place little or no value on a pension plan that generates benefits that will not be received for many decades, while someone with a very small r values a distant dollar of pension income nearly as highly as a dollar of current income. One way to think about ρ is that it is akin to an individual's own personal interest rate used to calculate how he or she currently values a future event. Thus, if my ρ equals 0.10, the present value that I place on \$100 to be received in 1 year equals \$100/(1 +0.10) = \$90.91. Note that ρ need not equal the market rate of interest.

[15] As indicated in the simple, one-period model, it is usually assumed that individuals are not fooled by any inflation of nominal values of wages, prices, and income. That is, if wage rates, prices, and all nonwage income all double, individuals will realize that they are no better or worse off; their real compensation rate is unchanged and their command over real resources is no different. Typically, life-cycle models convert all nominal values to real magnitudes by deflating the values of variables by an appropriate price index. Similarly, the interest rate used in the budget set is the *real rate of interest*, the nominal interest rate *minus* the premium that lenders require to compensate for any anticipated inflation.

[16] A life-cycle formulation of the theory of work-leisure choice can underpin empirical models that are either static or dynamic in spirit. That is, a life-cycle model can be used to generate hypotheses about behavior (or an outcome) that is observed during a specific sample period in which only a small fraction of the entire life cycle is observed. Explanatory variables might include measures of causal factors that represent information about circumstances that occur in nonsample periods. For instance, the work activity of a 63-year-old man observed in 1997 likely depends, to some extent, on his Social Security wealth (that is, the present value of future net Social Security payments) and the rate at which additional Social Security wealth will accrue with additional earnings. The farsighted planner anticipates future income needs when current-period work decisions are made. Alternatively, the life-cycle framework can be used to develop a dynamic model that explains the timing of retirement as one aspect of a planned sequence of work effort over the lifetime.

[17] The most common statistical procedures used to estimate retirement models are regression techniques, hazard models, and the method of nonlinear maximum likelihood.

[18] One common assumption about tastes and preferences in life-cycle models is that the utility function exhibits intertemporal separability. This property means that the marginal utility derived from consumption or leisure in any given period is independent of consumption or leisure in all other periods. This assumption substantially simplifies the nature of any influences that the values of financial variables in one period can have on behavior in another period. See Deaton and Muellbauer (1980, chapter 5).

[19] For more comprehensive reviews, consult Hurd (1990b), Leonesio (1990b), or Quinn and others (1990).

[20] Surveys of retirees conducted by the Social Security Administration and academic researchers between 1941 and 1963 usually indicated that a majority of respondents retired because of health problems or employer initiated terminations. See Boskin (1977), pp. 3.

[21] Boskin's data set comprised 131 households headed by white males from the 1968-72 waves of the University of Michigan's Panel Study of Income Dynamics. Sample selection was dictated by the requirement that these heads be between ages 66-70 in their last interview. Unfortunately, this data source has little information about private pension entitlements.

[22] A notable exception is Hurd and Boskin (1984), who also report a fairly large effect for Social Security.

[23] The data source was the 1973 CPS-IRS-SSA Exact Match File.

[24] The SSW variable is based on the husband's and wife's primary insurance amounts. It is calculated by taking the present value of the husband's benefits as a retired worker and adding the present value of the wife's benefits (that is, the higher of her expected benefits as a retired worker and the benefits she would receive as a spouse).

[25] The statistical work used data for 3,219 men, aged 45-59 in 1966, selected from the 1969 wave of the National Longitudinal Survey of Mature Men.

[26] This study examines data for 4,354 white married men, aged 58-63, selected from the 1969 wave of the RHS.

[27] The statistical analysis uses data for 4,845 white married males, aged 58-63, selected from the 1969 wave of the RHS.

[28] The study uses observations on 12,520 white married men (spouse present in 1969) and 5,436 white unmarried women from the 1969-75 waves of the RHS.

[29] The primary insurance amount values were calculated under the assumption of retirement in the survey year.

[30] They estimated a wage elasticity of 0.17, and compensated wage elasticity of 0.19 for men, with corresponding measures of 0.15 and 0.21 for women.

[31] The data are from the 1973 CPS-IRS-SSA Exact Match File, supplemented with information from the 1971 wave of the RHS. Models were estimated on a sample of approximately 700 men eligible for Social Security retirement benefits at age 62 had not received Social Security disability payments.

[32] To elaborate on this point, economists assume that individuals make decisions about consumption and leisure that maximize utility. Utility theory suggests that financial incentives (that is, price and income variables), as well as other nonfinancial control variables, influence the choices that are made. One approach to the empirical work would be to estimate the relationship between the outcome variable (for example, hours worked per period) and all available explanatory variables using statistical regression techniques, largely ignoring the properties of any particular utility function. Although this *reduced-form* method, in principle, then enables us to predict how changes in the various explanatory factors would affect the explained behavior, the estimated relationship is usually consistent with many specific utility functions. That is, from the reduced-form model it is impossible to determine the underlying mathematical representation of preferences that generated the observed behavior. As a consequence, the reduced-form approach makes it difficult to attribute differences in observed choices between individuals to differences in budget constraints as opposed to differences in their tastes and preferences.

[33] For example, a reduced-form labor-supply model for older workers might explain annual hours of work using currently available benefits and the anticipated increment to the present value of anticipated Social Security benefits as explanatory factors. Even if the model includes many other precisely measured variables, the model lacks sufficient detail about how Social Security can affect work incentives to allow one to compare and contrast the effects of changes in many specific program features such as the benefit formula, the taxation of benefits, or the retirement test.

[34] The *structural* approach begins by assuming a specific utility function (or functional transformation such as the marginal rate of substitution function, indirect utility function, or expenditure function) whose parameters are to be estimated. The database typically contains information that allows the investigator to reconstruct the opportunities embodied in the individual's budget constraint. The statistical estimation procedure involves determining the values for the utility function parameters that maximize the likelihood of occurrence of the observed outcomes documented in the data. Once the specific utility function is determined, it is possible to predict the response to changed opportunities because behavior would adjust to maximize utility in light of the new circumstances.

[35] The study used data for 5,327 white males who were not self-employed, selected from the 1969-73 waves of the RHS. Because three waves of information are used for each individual, the total number of observations is 15,981. Ages 58-67 are represented in the sample.

[36] "Full income" is the total amount of income that would be available to spend if all time were devoted to work.

[37] The measure of lifetime potential earnings is calculated by taking the present value of earnings assuming full-time work until age 67, and no work thereafter.

[38] The empirical work is based on cross-section data for 1,483 men and 1,207 women collected for 1977 by the British Office of Population Censuses and Surveys.

[39] "Waiting wives" are women older than age 60 whose husbands were not yet age 65 and who thus could not receive a State pension.

[40] Whether the Social Security system as a whole promotes earlier retirement in this way depends on the extent to which individuals are forced by the program to save more for their retirement than they would have otherwise. In the case of forced savings, older workers end up with greater assets to finance retirement.

[41] For retired workers the AIME is calculated by first adjusting annual Social Security taxable earnings prior to age 60 for average wage growth in the economy. Earnings at later ages are not adjusted. The number of computation years (call this number y) is then determined; that is, the number of years worked after 1950 (or the year of attainment of age 21, if later) up to the year in which the individual attains age 62, minus dropout years (usually 5). The actual computation years are then selected based on the y years over the individual's lifetime with the highest taxable earnings, after making the wage-growth corrections for pre-age 60 earnings. The AIME is then calculated by summing the adjusted earnings in the computation years and then dividing by the total number of months in the computation years.

The primary insurance amount (PIA) is the monthly amount payable to a retired worker who begins receiving benefits at age 65, and is calculated as follows for persons attaining age 62 in 1992 or later. The PIA is computed using a formula consisting of three brackets in which different percentages are applied to the worker's AIME. The two *bend points* that define the three brackets are different for each calendar year of attainment of age 62, a program feature intended to account for average wage growth in the economy. For example, the 1997 bend points are $455 and $2,741. To compute the PIA for a retired worker who attains age 62 in 1997, take 90 percent of the first $455 of the AIME, add 32 percent of the next $2,286 of the AIME, and add 15 percent of the amount of the AIME that exceeds $2,741. The result of this computation is the "age-62 PIA." The PIA of a new beneficiary who is older than age 62 is further adjusted for cost-of-living increases granted to beneficiaries since the year in which the individual attained age 62. These are simplified explanations that can vary with an individual's circumstances. For more accurate details consult the *Social Security Handbook, 1993.*

[42] In 1997, the taxable maximum is $65,400.

[43] In 1997, beneficiaries aged 62-64 face an annual earnings limit of $8,640. Earnings in excess of this amount lead to a benefit reduction of $1 for every additional $2 earned. For beneficiaries aged 65-69, the annual earnings limit is $13,500, and excess earnings result in a $1 reduction in benefits for every $3 earned over the limit. For some exceptions to these rules, see Myers (1985), chapter 3.

[44] Fields and Mitchell estimated variants of their model using data for a sample of 1,024 men aged 59-61 in 1969 selected from the RHS, and information for 8,733 men who retired between the ages of 60 and 68, as documented in the Benefit Amounts Survey.

[45] The model permits transitions among three States: not retired, partially retired, and completely retired. Respondents were asked in each survey year whether they considered themselves to be completely retired, partially retired, or not retired at all.

[46] The model was estimated using data for 494 white males drawn from the 1969-75 waves of the RHS.

[47] The study uses data for 4,603 men selected from the 1969-77 waves of the RHS.

[48] The model was estimated using data for 1,335 respondents from the National Longitudinal Survey of Mature Men for the years 1965-75. Those with wealth below $4,000 in 1966 were excluded from the sample.

[49] Information was taken from all six waves (1969-79) of the RHS. The sample consisted of 2,000 men who were not self-employed.

[50] The *hazard* is defined as the probability that the particular event of interest (in this case, retirement) occurs during a specified interval, given that the occurrence of the event is possible (that is, in this case, given that the person has not yet retired).

[51] The study used data for approximately 8,500 male heads of households selected from the 1969-77 waves of the RHS.

[52] Data were used for 1,356 respondents for the years 1966-78, selected from the National Longitudinal Survey of Mature Men. Of these men, 428 aged 45-71 were fired during the observation period and provided sufficient information to estimate a competing-risks model.

[53] The study was based on the behavior of 4,193 men selected from the RHS. Data from all six waves were used. Excluded were farmers and men who reported substantial income from welfare programs, civil service pensions, or railroad retirement benefits.

[54] Burtless defined retirement as occurring at the first discontinuous drop in annual hours of work not connected to a spell of unemployment that ends in return to full-time work.

[55] The data used were from 1,633 males selected from the 1971-79 waves of the RHS.

[56] The model was estimated using data on 8,131 men selected from the RHS. Note that the final estimated retirement model uses the information on considerably fewer than the initial 8,131 respondents. The initial larger sample serves to supply data for the estimation of preliminary information on worker beliefs about future values of the retirement determinants included in the model. The final retirement model is estimated on a subsample of respondents who receive Social Security retirement benefits but no private pensions, and who have fairly complete data in the RHS.

[57] A total of 2,497 job histories were constructed from the 1966 to 1983 waves of the National Longitudinal Survey of Mature Men. The estimation procedure uses a subsample of 500 persons aged 55 or older at the start of the survey.

[58] The option value approach is discussed later in this article.

[59] See Gustman, Mitchell, and Steinmeier (1994) for a recent review of current thinking on the economic role played by pensions in the labor market.

[60] In *cliff vesting*, an individual's pension status changes from nonvested to 100 percent vested (that is, eligible to receive accrued pension benefits at the normal or early retirement age regardless of whether he or she remains with that employer) at a particular point in service tenure.

[61] The sample comprises nonmanagerial office personnel and is different from the sample of salesmen used in other research by Stock and Wise (1990a,b), although the employer is the same.

[62] The study used data from a sample of 4,000 (1,720 women and 2,280 men) New York State government employees.

[63] Under current law the annual earnings limit for beneficiaries aged 65-69 will gradually increase from its 1997 amount of $13,500, eventually reaching $30,000 in the year 2002. The 1983 amendments to the Social Security Act call for the DRC to increase gradually to 8 percent in 2008, a level which is thought to be actuarially fair, on average. An actuarially fair DRC will fully restore any benefits lost because of the earnings test in the short term by increasing future benefit payments. Because the present value of resulting future increases equals the value of current benefit reductions, an actuarially fair DRC virtually eliminates the earnings test penalty.

[64] There is also an important interaction between the two, with individuals who claim health limitations approximately eight times as responsive to Social Security benefits.

[65] This conclusion was reached by Sammartino (1987).

[66] More technically, husbands' labor-supply functions frequently treat the labor supply of wives as strictly exogenous.

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