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This paper presents statistics which confirm the existence of minimum hours constraints for jobs held by a majority of prime aged male workers who are not self employed. It then considers the implications of these constraints for studies of retirement behavior and related policy analyses. Potential biases associated with conventional analyses, which either ignore the existence of minimum hours constraints or assume they are pervasive, are discussed in the context of structural life cycle retirement models. A more realistic but still imperfect specification, which can be estimated given available data, assumes minimum hours constraints on the main job and variable hours elsewhere.

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Economists have devoted a great deal of effort to studying the basic retirement model and to analyzing the roles of public and private pensions in influencing retirement decisions. Unraveling the complex set of incentives created by the Social Security System and by a variety of private pension programs has proved to be a very difficult task.[1] Analyses of the budget line facing the potential retiree have been conducted in the context of retirement models with specifications that have become increasingly sophisticated over time.

Developments in specifying retirement models reflect progress that has been made along a number of lines. Most importantly, it has been learned that because both the budget constraint and the indifference map affecting behavior in any year are themselves affected by decisions made in other years, the retirement decision must be analyzed in a life cycle context rather than in a labor-leisure choice framework set within a particular year.[2] Moreover, despite the fact that most empirical retirement studies are of the reduced form variety [e.g. see Clark and Johnson (1981) and Boskin and Hurd (1978)], it has become apparent that the underlying structural equations, and especially the parameters of the utility function, must be estimated if we are to determine the effects of a number of proposed policy changes such as raising the early and normal ages for receipt of social security benefits to 65 and 68, or raising the minimum legal age for mandatory retirement to 70. Reduced form equations are unable to provide accurate estimates of the impact of such changes both because of the difficulty of capturing all the twists and turns in the budget line and because the proposed changes take us outside the range of past experience. Recently, a first attempt was made to estimate a retirement model that is both structural and is formulated in a life-cycle context. This is the important contribution of Gordon and Blinder (1980).[3]

Now that we have reached a point where the technical approach is on the right track, it is appropriate to consider the specification of the retirement model, and in particular the assumption as to the constraints facing the potential retiree. Embedded in models used to estimate utility function parameters are various assumptions regarding available employment opportunities. One possibility is that individuals decide each year whether to continue to work full-time or to retire completely that year.[4] Such an all-or-nothing work decision may be ascribed to the interdependence of inputs in the production process, as noted by Deardorf and Stafford (1976). Another approach assumes that individuals choose their level of work effort in a particular job on a year by year basis, and hence that individuals are free to retire by gradually reducing their work effort over time. This kind of model was used by Gordon and Blinder (1980). Combinations of the above two models are also possible. An example of such a hybrid would posit that the individual is constrained to work full-time or not at all in his main job, but can work part-time in a partial retirement job at the penalty of receiving a lower wage rate. As we shall see in this paper, this type of hybrid appears particularly attractive in view of the available evidence.

Our earlier work (Gustman and Steinmeier, 1981) suggests, but only indirectly, that constraints which force an individual to work at least a minimum number of hours on the main job may play an important role in the retirement process.[5] Empirical evidence presented there documents the importance of partial retirement in jobs other than the primary job. Partial retirement is found to be a fairly common phenomenon, with at least one third of those in our sample of older workers having retired partially at one time or another. For workers over 65, partial retirement was found to be as common as nonretirement. But what is most consistent with a view that minimum hours constraints affect retirement behavior is the finding that those who partially retire usually do not do so on jobs they held full-time at age 55, despite the fact that these "main jobs" carry higher wage offers than do the newly acquired jobs held by the partially retired.[6] While these findings are consistent with a view that minimum hours constraints on the main job influence retirement behavior, and the magnitudes involved suggest that potentially this influence is important, they of course do not provide direct evidence on either (1) the pervasiveness of lower limit constraints on hours of work, or (2) the impact of ignoring these constraints. In Section I below, we attempt to document more directly that these constraints are a common phenomenon.

Minimum hours constraints have important implications for studies of retirement behavior because ignoring these constraints may lead to biased estimates of the parameters of the utility function. On the one hand, since most people do not partially retire, they are observed to shift their labor supply discontinuously from full-time work to full retirement. Any analysis which does not incorporate a minimum hours constraint must assume that this behavior is voluntary and attribute it to some characteristic of the utility function. On the other hand, a substantial fraction of older workers partially retire in jobs which have reduced wages compared to the wages paid in the main job. An analysis which ignores minimum hours constraints is likely to consider the drop in wages as exogenous and will attribute partial retirement to a change in the budget constraint rather than to a shift in the utility function over time. Section II considers the nature of the bias in the estimated parameters of the utility function that arises if there are minimum hours constraints and they are ignored, or if partial retirement is mistakenly viewed as a result of an exogenous drop in the wage rate rather than as an endogenous choice brought on by minimum hours constraints in the main job.

If minimum hours constraints are ignored and utility function parameters are biased as a result, projections based on the estimates may lead to incorrect predictions as to the course of retirement and to mistaken analysis of the effects of changes in pension or social security policy. Further, if the model treats partial retirement at reduced wages as a response to an exogenous change in wage rate rather than as an endogenous choice of a job with lower wages, it cannot be used to determine whether those who postpone retirement as a result of some policy change remain in main jobs, earning high incomes while competing with prime age workers or with those attempting to secure a job with training opportunities and the potential of a fruitful long term relationship, or whether they are putting in a limited number of hours on part-time jobs, competing with secondary workers.

Such considerations underline the importance of obtaining accurate estimates of utility function parameters based on properly specified opportunity sets. In order to obtain such estimates, we are in the process of analyzing a full structural model which incorporates a minimum hours constraint. Some of the questions pertaining to the magnitude and direction of the biases to be discussed in Section II can only be analyzed in the context of that model. To set the stage for later empirical analysis, Section III of this paper discusses the information available in three major longitudinal data sets, each of which appears to have shortcomings for use in an appropriately specified life cycle model.

I. The Prevalence of Minimum Hours Constraints

In this section we will look at evidence pertaining to minimum hours constraints. These are constraints which limit the opportunities for an individual to work fewer hours than full-time in his current job. Perhaps the best data source for examining the extent of these constraints in the Michigan Panel Study of Income Dynamics (PSID). The PSID contained the following question: "Could you have worked less if you had wanted to?" Columns 1 and 2 of Table 1 tabulate the answers to this question for several groups of males who were working, but not self-employed. Unfortunately, a significant percentage of the sample was not asked this question due to the routing pattern of the questionaire; these people are included in the third column. The people who were routed around this question had previously indicated that they would have liked to work more on their present job but couldn't. Column 4 calculates the number of employees who faced a minimum hours constraint as a fraction of those for whom an answer could be determined.[7]

The overall impression gained from Table 1 is that minimum hours constraints are a very common phenomenon. Line 1 of the table indicates that 41 percent of prime-age males reported that they could not reduce their hours of work. Of those for whom a response could be determined, over half (56%) said that they do face such a constraint.

It should be recognized that these figures might understate the number of individuals subject to a minimum hours constraint due to the nature of the question. For one thing, individuals may indicate that there is downward flexibility in their hours of work even if they can reduce hours only transitorily rather than permanently. For another, individuals who work some amount of voluntary overtime might respond that they could reduce their present work week even though they would ultimately face a minimum hours constraint. Line 2 of the table attempts to shed light on the latter source of downward bias in the indicated number of constrained individuals by including only individuals who usually worked 42 hours or less per week, and who presumably were less likely to be working overtime than people working longer hours. With this sub-sample, 61% of those for whom a response could be determined reported that they faced a minimum hours constraint, although the overall percentage reporting a constraint remained the same as before, at 41%.

The implication of minimum hours constraints of concern here is that they may affect retirement decisions by forcing an individual to choose between full-time work on the main job, part-time work in another job at lower wages, or complete retirement, rather than allowing some intermediate amount of work effort in the same job at unchanged wages. For this reason it is of interest to know how many people in an older age range report that they are facing this kind of constraint. Line 3 of Table 1 reports this information for individuals aged 55 to 65, which is the age range in our society when many people begin to consider retirement. These figures do not show great differences from the analogous figures for the younger age groups. The same is true for line 4 of the table, which reports the percentages facing minimum hours constraints among individuals who are covered by pensions. Line 5 does the same for union members and suggests that union members are somewhat less likely to face these constraints than are non-union employees.

Table 2 breaks the responses down by occupation and industry, again reporting results for prime-age males.[8] These figures are largely in accord with our expectations. Laborers (62% of those who responded to the question) and operatives (59%) were most likely to be constrained, and managers (at 49%) least likely. By industry, those most likely to report a constraint are in the medical profession or in the army, with 70% or more of the individuals responding to the question reporting a constraint. There are eight other industries in which 60% or more of the responding individuals report a constraint. Those least likely to report a constraint are in mining, paper, transportation and communication, but even in these industries, more than 40% of the responding individuals report a constraint.

A second data source with information on the extent of minimum hours constraints is a 1979 survey with 267 responding organizations by the American Society for Personnel Administration and the Bureau of National Affairs (ASPA-BNA).[9] Approximately one-half of the responding establishments are manufacturing companies, one-third non-manufacturing business and about one-fifth nonbusiness organizations (hospitals, universities, government organizations, etc.). According to the survey, while over half of the firms make arrangements for some employees to stay on as consultants, and sometimes recall retirees for temporary assignment, only 15% of the responding firms, and only

10% of the manufacturing firms, have a "tapering off" program in which at least some employees can reduce their work time as they approach retirement. Only 7% have such programs covering all employees. The percentages are similar among large firms (more than 1000 employees) and small firms (fewer than 1000 employees).

This survey thus gives the impression that the percentage of individuals who are free to reduce hours immediately prior to retirement is on the order of 10%, whereas the statistics from the PSID suggest a substantially higher number. In the PSID survey, it may be reasonably argued for individuals in the "not ascertained" category that if a person cannot increase his work week, it is likely that he also cannot reduce it, i.e., that most of these individuals should be counted as facing a minimum hours constraint. Even so, the PSID data would still indicate that a quarter to a third of the individuals are free to reduce their hours of work. However, the PSID question is sufficiently vague that it is difficult to be sure that most of those who report no constraint can in fact reduce their work time much, even if the sample is confined only to those who normally work 42 hours or less per week. People might be able to take a little more sick leave, or take a week or two without pay, or even to reduce their work effort on the job a little, but there may nevertheless be fairly strong limits to the extent to which work effort can be substantially reduced by these means.

II. Implications for the Estimation of Utility Function Parameters

In order to estimate the effects of changes in pension rules or social security rules on retirement behavior, especially for large changes in these programs, it is necessary to obtain estimates of the parameters of the utility function which underlies retirement behavior. Such parameters may be estimated in the context of a model which hypothesizes that individuals maximize utility subject to a particular opportunity set. The opportunity set is very much affected by whether there is a minimum hours constraint. Accordingly, so are the utility function parameter estimates. In this section we will illustrate how inappropriate assumptions regarding a minimum hours constraint may result in biased estimates of utility function parameters.

A. Biases From Ignoring a Minimum Hours Constraint.

First, suppose that most people are subject to a minimum hours constraint, but that the investigator ignores it and instead assumes that hours may be freely varied between full-time work and full-time leisure. A common model which reflects the investigator's assumption involves a lifetime utility function

$$(1) \quad U = \int_0^T u[C(t),\ L(t),\ t]\ dt$$

which is maximized to subject to the budget constraint

$$(2) \quad \int_0^T e^{-rt}\ C(t)\ dt = A_o + \int_0^T e^{-rt}\ W(t)\ [1 - L(t)]\ dt$$

where C(t) is consumption at time t, L(t) is leisure at time t [measured in units so that L(t) is in a range from 0 to 1], A_o is initial wealth, and W(t) is the wage rate at time t. The explicit inclusion of time in the utility function reflects both any discount factors that may be appropriate and any changes in the relative valuations of leisure and goods which arise because the marginal disutility of work increases with age.

To estimate such a model, it is necessary first to specify a functional form for the utility function and to introduce a stochastic structure. With the present model, a straightforward way to do this is to write the utility function as

$$(3) \quad u[C(T), L(t), t] = \{[C(t)]^{-\rho} + e^{[X\beta + \varepsilon]}[L(t)]^{-\rho}\}^{-\frac{\nu}{\rho}}$$

This is a CES utility function with elasticity $\sigma = 1/(1 + \rho)$, and degree of homogeneity ν. The relative valuations of consumption and leisure depend on a set of exogenous variables in the vector X, and an error term presumed to come from some specific distribution, e.g. normal. Time (or age) is also incorporated in the vector X. For any specific values of the parameters β, ν and ρ, and for the set of exogenous variables X for an individual in the sample, there is some value of ε for which the model predicts a value of labor supply just equal to the amount which the individual does in fact supply. The probability density of this value of ε is the individual likelihood for this person. Note that the required value of ε, and hence the individual likelihood, will be different for different values of the parameters β, ν and ρ. The maximum likelihood values of these parameters are simply the values which maximize the product of the individual likelihoods for all the individuals in the sample, or in other words, the parameter values from which the sample is most likely to have come. This is a relatively easy procedure to outline, but it is a computationally burdensome procedure to implement. In practice, investigators frequently introduce simplifications and assumptions to make the problem computationally more tractable.

If the path of wages over time is reasonably stable, the model specified above, a model with no constraints on hours worked, implies a more or less gradual transition from full-time work to complete retirement. If individuals are in fact subject to a minimum hours constraint, however, we instead will observe a very rapid transition from full-time work to retirement. The estimation procedure adjusts the estimates of β and ρ to maximize the likelihood function in view of these observations, and in the process of doing so it may produce biased estimates of the parameters. To see the source of the bias, consider the labor supply decision of an individual for a small time period around the time of retirement, as illustrated in Figure 1.[10] Heuristically, the estimation procedure may account in one of two ways for the rapid transition from full-time work to complete retirement.

One possibility - a theoretical possibility that without firmer behavioral grounding is not very plausible - is that the indifference curves exhibit a low or moderate elasticity of substitution between earnings and leisure, but that the curves are rotated rapidly between the time just before the individual retires and the time after he retires. This is illustrated in the left panel of the figure. The substance of this explanation is that something happens around the time of retirement that suddenly and greatly increases the individual's marginal disutility of work. In an estimation procedure, the algorithm would associate this behavior either with age or with some variable which changes rapidly and uniformly across people and which could therefore account for this kind of behavior. However, it cannot be attributed strictly to age, since people retire at a variety of ages in the late fifties and sixties, and there are unlikely to be explanatory variables which always undergo a dramatic shift around the time of retirement. Hence, the maximization algorithm is likely to focus on a second explanation, namely that the elasticity of substitution is rather high, so that a slight tilt of the indifference curves is enough to cause the sudden shift of the point of tangency between the indifference curves and the budget line. This situation is illustrated in the right panel of the figure.

Ignoring a minimum hours constraint, then, is likely to produce a rather high estimate for the within-period elasticity of substitution between earnings and leisure. However, the estimation procedure must find the general slope of the indifference curves to be close to the wage rates for all individuals; otherwise for some individuals a small shift in the slope of the indifference curves would be insufficient to make them retire. Hence, the estimation procedure would tend to assign coefficients to the explanatory variables so that the general slope of the indifference curves in the right panel of the figure is close to the wage rate for as many individuals as possible, and it would use the error term ε to resolve any remaining discrepencies between the wage rate and the slope of the indifference curves. This would bias the coefficients of the utility function toward values which are in fact appropriate more for the wage equation.

A somewhat different bias can arise if the estimation procedure utilizes only information about whether or not the individual has stopped working, as in Gordon and Blinder (1980). In the absence of a minimum hours constraint, the reservation wage is tangent to the indifference curve at the point of no income and no work, as illustrated by the dotted line which is tangent to the indifference curve at point A in Figure 2. With a minimum hours constraint, the reservation wage is steeper than the indifference curve at A. In the figure, point B corresponds to the minimum hours of work if the individual chooses to work, and the dashed line corresponds to the associated reservation wage. If the actual wage were higher, then the individual could reach some point above and to the left of B which is preferred to A, while if the wage were less, point A would be preferred.

If the estimation procedure ignores the minimum hours constraint when it is in fact present, the reservation wage represented by the dashed line will be inferred to be the slope of the indifference curves at A. Hence, the indifference curves will be estimated to be too steep. If all jobs in a sample involve a minimum hours constraint, or if the explanatory variables X in the utility function of equation (3) are uncorrelated with the presence or absence of a minimum hours constraint, then the only bias may be that the constant term in the linear form βX is estimated too high. If some of the explanatory variables are correlated with the presence or absence of the constraint, however, then estimates of other parameters may also be biased. Suppose, for example, that people with high education are more likely to be in jobs without a minimum hours constraint. That means that such people are more likely than average to have a budget line represented by the dotted line in Figure 2. The estimation procedure will infer that high education tends to be associated with flatter indifference curves, all other things equal, and this will bias the coefficient of education in βX in Equation (3) downward.

B. Biases From Treating the Wage Decline Associated with Partial Retirement Jobs as Exogenous

The descriptive statistics presented in the previous section should lead one to question the plausibility of any assumption that individuals are free to reduce gradually their working hours at unchanged wages as they approach retirement. Just the opposite assumption might seem to be more defensible on the basis of the evidence. The fraction of individuals who are free to reduce their working hours appears to be no more than 40% and perhaps as little as one-tenth. Particularly if this latter figure is closer to the truth, it can be argued that an empirical investigation based on a model which assumes that everyone is constrained would be acceptable.[11]

However, our earlier work casts doubt on a model which assumes that everyone works in a job with fixed working hours until a certain age, and then retires completely. That work, based on the Retirement History Survey, found that almost a quarter to a third of the individuals in the sample spent at least some time in partial retirement, usually in a job other than the one at which they had worked for most of their lives. Such a finding suggests that an older person nearing retirement age does not face a simple dichotomous choice between complete retirement and a full-time job. Rather, he faces a three-way choice between complete retirement, full-time work in his primary job, and part-time work, probably at a lower wage, in a different "partial retirement" job.

In such a setting, public and private pensions aside, the wage rate in the full-time job is not a true measure of the opportunity cost of leaving that job. If the individual quits the full-time job and works in the partial retirement job, the opportunity cost is the difference in utility levels between the full-time work, high wage package available on the main job and the part-time work, lower wage option available if partial retirement is elected.[12] One would suspect that failure to allow for the partial retirement option would bias estimates of the parameters of the utility function. The nature of such a bias can be demonstrated. To begin, Figure 3 compares the hypothetical labor supplies of the same individual for two different environments, one in which the individual has the opportunity to work at reduced hours in a second job and one where this opportunity is lacking. Time B is the time when the individual retires from the job if he has no alternatives to the full-time job. If an alternative job is available, time A is the time when the individual leaves the full-time job, and time C is the time when the individual leaves the partial retirement job. It is also possible that if the wage on the partial retirement job is low enough in comparison to the wage on the full-time job, the job is so unattractive as to be irrelevant. In this case, the individual would continue to retire at time B whether or not the alternative job were available.

The figure is drawn so that time A occurs before time B, and time B before time C. It can be shown that this is indeed the case for a wide variety of commonly-used utility functions. In particular, for a utility function that is homogeneous in consumption and leisure, a sufficient condition for this result is that $1 - (1/\sigma) \leq \nu \leq 1$, where σ is the elasticity of substitution between consumption and leisure, and ν is the degree of homogeneity. Note that this relation will be satisfied by any utility function, such as the Cobb-Douglas or the C.E.S. function, that is homogeneous of degree one, or by any function where both the elasticity of substitution and ν are less than one.

To sketch how this result arises, suppose that the two paths were such that time A occurred after time B. Let MU_Y be the marginal utility of discounted lifetime income along the solid path (i.e., with no partial retirement), and consider the implications of this same MU_Y along the dashed path (with partial retirement). With the condition $1 - (1/\sigma) \leq \nu \leq 1$, the MU_Y for which lifetime consumption just equals lifetime income (properly discounted) along the solid path must cause lifetime income to exceed lifetime consumption along the dashed path.[13] This means that MU_Y, the marginal utility of lifetime income, must be lower along the dashed path than along the solid path. Between time B and time A, the individual would be working and earning income along the dashed path but not along the solid path, in spite of the fact that the marginal utility of income is lower along the former than along the latter path.[14] This inconsistency contradicts the hypothesis that time B precedes time A and establishes that the termination of full-time work occurs earlier if a partial retirement job is available. A symmetric argument establishes that time B does indeed precede time C, that is, that the person completely retires later if a partial retirement job is available and taken.

Now suppose that X_i is a variable which does not influence the preferences of individuals but which is positively correlated to wage differentials between full-time and partial retirement jobs. For example, an accountant ($X_i = 1$) may have skills which are reasonably transferrable to typical part-time jobs in the service industry, but a production worker on a specific assembly line ($X_i = 0$) may not. In this situation, a person who has a low value of X_i and hence a low wage in the partial retirement job may find such a job irrelevant and will work in the full-time job up until complete retirement. A person with a high value of X_i, and hence a higher wage in the partial retirement job, is more likely to find that job attractive enough to work at it for some period of time.

To see the source of bias from an estimation procedure that imposes a minimum hours constraint but ignores partial retirement, turn to Figure 4. Notice first that this figure is drawn consistent with the assumption by the investigator that hours are fixed at full time, and therefore that leisure can be affected only by adjusting the date of retirement. That is, this figure illustrates how the indifference curves which assume full-time work appear to the investigator when, contrary to his assumption, the partial retirement option is available; it should not be interpreted as the appropriate diagram for analyzing the labor supply decision when hours are in fact variable.

Consider now two individuals who have identical wages in their full-time jobs and who are otherwise identical, save that one has a low value of X_i and does not work in a partial retirement job while the other has a high value of X_i and does partially retire. Figure 4 illustrates how the estimation algorithm views these two individuals, who will be denoted as I and II, respectively. For individual I, the budget constraint has a slope equal to the wage rate in the full-time job until the time of retirement B, and the unobserved budget constraint past that point is assumed to continue at more or less the same slope. In fitting utility function parameters, an estimation procedure will infer that the indifference curves of individual I are tangent to his budget constraint at time B. This indifference curve is labelled as I in the figure. For individual II, the observed budget constraint consists of one segment with a slope equal to the full-time wage until time A, when he leaves the full-time job, and another segment between time A and time C which has a slope equal to the wage in the partial retirement job. The unobserved budget constraint past that point is usually assumed to have a slope similar to the slope in the last observed job, resulting in a complete budget constraint for this individual which is indicated by the dashed line in Figure 3 and labelled II. If time C is taken as the date of retirement for this individual, a procedure which attempts to estimate utility function parameters will infer that the indifference curves are tangent to budget line II at that point. Hence, the indifference curves will be presumed to look something like the curve labelled as II in the figure.[15]

Many utility functions commonly used in estimation (e.g., Cobb-Douglas, C.E.S.) are homothetic, that is, they have the same slope along any ray from the origin. If such functions are used the estimation algorithm will observe that the slope of the indifference curve I along the ray labelled M is steeper than the indifference curve II along the ray labelled N. If ray N is steeper than ray M, this can occur for convex indifference curves only if the curves for individual I are rotated relative to the curves for II in such a way that the first set of curves display a higher relative preference for leisure. Since this is observed to be correlated with X_i and since the two individuals are in all other respects identical, the estimation procedure will impute a negative effect of X_i on the relative preference for leisure in the utility function, even though X_i does not enter the utility function at all. Hence, a failure to consider an alternative partial retirement job in the estimation procedure can produce biased estimates of the parameters of the utility function. An analogous argument for bias can be made if X_i is a variable which, for other reasons, truely belongs in the utility function.

C. A Model With Partial Retirement.

Since many individuals appear to face fixed hours constraints on their full-time jobs but are able to work part-time by taking partial retirement jobs at lower wages, some blend of the previous two models is necessary to avoid the biases which either alone would produce. In this hybrid model, there are two jobs. One has a constraint on the number of hours worked, and the other has a lower wage rate than the first, but does not have any constraints on hours worked. An optimizing individual in this model would maximize the lifetime discounted utility function

$$U = \int_0^T u[C(t), L(t), t]\, dt$$

subject to the following constraints

$$1 - L(t) = H_1(t) + H_2(t)$$

$$\int_0^T e^{-rt} C(t)\, dt = A_o + \int_0^T e^{-rt} [W_1(t) H_1(t) + W_2(t) H_2(t)]\, dt$$

$$H_1(t) H_2(t) = 0$$

$$H_1(t) [1 - H_1(t)] = 0$$

where $H_i(t)$ and $W_i(t)$ are hours worked and wages in the i^{th} job, and where all other variables are the same as defined previously. The first constraint says that time not spent at leisure is split between the two jobs, and the third constraint says that the time is allocated entirely to one or the other job. The second constraint is the familiar budget constraint, and the last equation limits any time spent in the first job to full-time work or none at all. An estimation procedure built around the (non-trivial) solution to this problem will avoid the problems of bias which would arise if the possibility of individuals working in partial retirement jobs is ignored.

III. Considerations of Available Data

Ideally, an estimation procedure should consider, for each individual, the opportunity set that individual is facing. This includes the wage history in the individual's full-time job, whether or not he can reduce hours in that job, and potential wages in any relevant partial retirement jobs. For each person, the individual likelihood would be calculated based on the model appropriate to that individual, and the likelihoods would then be multiplied to yield an overall likelihood function which could be maximized with respect to the parameters of the utility function. Unfortunately, this procedure makes considerable demands on the data, and no data source is currently available which would enable this procedure to implemented in a completely satisfactory manner. In this section, we will discuss the relative advantages and disadvantages of three of the major microeconomic data sets which might be used in the estimation process. These three data sets are the Retirement History Survey (RHS), the Michigan Panel Study of Income Dynamics (PSID), and the National Longitudinal Study of Mature Men (NLS). Six aspects of these surveys are particularly relevant to researchers trying to estimate parameters relevant to retirement behavior.

1. Hours Limitations. The PSID has by far the best information on hours limitations in current jobs. On two of its surveys the NLS asked whether the individual wished to reduce hours but couldn't. The answers to this question indicate that only a relatively small number of individuals felt such a constraint to be binding (13% in 1971 and 7% in 1976), but it must be noted that this question asked whether an individual wished to reduce hours, whereas the PSID question cited earlier asked whether an individual could reduce hours if he wanted to. No information on hours constraints is available from the RHS.

2. Mandatory Retirement. Both the NLS and the RHS attempt to find out if the individual is subject to mandatory retirement provisions. The NLS questions always pertain to the current job. In the first year of the RHS, if the individual already considered himself to be retired or partially retired, the survey inquired about mandatory retirement provisions on the last job on which the individual worked full-time, which is closer to the information that is really being sought. No information on mandatory retirement is available from the PSID.

3. Pension Coverage. All three surveys inquire about pension

coverage. The RHS and the NLS do so every year, whereas the PSID asks about such coverage only in one of the later years. The RHS additionally asks each year the ages that individuals will be eligible for normal and early retirement in their current jobs. The NLS inquires about early retirement only in two years, but in those years it asks the expected pension amounts both for normal retirement and for early retirement. These are the kinds of figures which are necessary to calculate the increment of pension wealth due to working between these dates [the DELTA used by Burkhauser and Quinn (1981)]. Unfortunately, these questions are only sporadically answered, and the quality of the answers is open to considerable doubt.

4. Wage History. All three surveys ask about the wage rate each year in the current job. The RHS additionally provides several pieces of information relevant to constructing a wage history. One piece of information is a matched Social Security record which gives on a year by year basis the amount of Social Security covered earnings. The RHS also asks about wages in the first and immediately previous jobs, and it inquires about the ages at which the respondent earned one-third and one-half of his 1971 salary.

5. Partial Retirement Jobs. The RHS each year contains a question whether the individual considers himself to be completely retired, partially retired, or not retired at all. This question can be useful in distinguishing a movement from a full-time job into a partial retirement job as opposed to a movement from one full-time job into another full-time job. In the other surveys, the distinction between these two movements must be made on the basis of a drop either in usual hours worked per year or in the wage

rate (A lower wage rate may indicate an easier partial retirement job). The distinction will therefore contain a degree of arbitrariness and may be subject to a considerable margin of error.

6. Sample size. The RHS contains about 11,000 individuals initially aged 58-63, and it surveys them bianually starting in 1969. This survey clearly provides the most observations in the relevant age range (the early and mid 60's) for studies of retirement behavior. The NLS surveys about 5,000 individuals initially aged 45-59 for a period of 10 years from 1966 to 1976, which means that it includes several thousand individuals during their early and mid 60's. The PSID covers more than 5,000 hourshold s, but with no particular restrictions on the ages of the individuals. As a result, it has considerably fewer observations of people in the relevant age range than do the other two surveys.

None of these data sets allows for a complete specification of the budget constraint. The PSID provides some information about the presence or absence of a minimum hours constraint but contains no information on mandatory retirement. The RHS and the NLS indicate whether or not the individual faces mandatory retirement, but of these two only the NLS contains any information on minimum hours constraints, and very fragmentary evidence at that. Hence it is not possible to ascribe to each individual the correct budget constraint, and some other method must be used to obtain estimated parameters.

If one believes that the percentage of individuals who do face minimum hours constraints is as high as 90 percent, as may be implied by the ASPR-BNA study, a reasonable approximation may be to treat everyone as though they were subject to this constraint in their primary job unless there is obvious evidence to the contrary, such as an individual who actually reduces work effort without changing jobs. This procedure would mistreat some individuals who are not subject to the constraint, but if the number of individuals so mistreated is fairly small, one may use surveys such as the RHS and NLS and hope that the impact of these individuals on parameter estimates is not large.

A more sophisticated but more complicated procedure would be to use the information from one survey on the relative percentages of individuals subject to fixed hours constraints as a priori information in an estimation based on data from another survey. For instance, let $f^c(\beta, X_i)$ be the individual likelihood for individual i using a model where he faces the constraint, and $f^{\bar{c}}(\beta, X_i)$ be the likelihood for the same individual using a model where he does not face the constraint. Now suppose that from the PSID is determined the fraction p_c of the individuals from a particular industry-occupation classification who are subject to a minimum hours constraint. Then, when forming the likelihood for an individual in the RHS or NLS, the likelihood could be written as

$$p_c f^c(\beta, X_i) + (1 - p_c)\ f^{\bar{c}}(\beta, X_i)$$

where the likelihood with each model is weighted by the probability that the model is correct. This procedure is probably necessary if the number of individuals who are not subject to the constraint is closer to the forty percent figure rather than the one-tenth. (In the latter case, the improvement in estimates from using the more complicated estimation procedure may be relatively small.) It also improves if one can find some exogenous variables which are strongly correlated with the probability p_c and hence which can be used to establish which individuals have a p_c close to one and which individuals have a probability close to zero.

IV. Concluding Remarks

Considerable progress has been made in our efforts to understand retirement behavior, and the impact on this behavior of pensions, social security and other features of the labor market which affect the rewards to work. To predict the course of retirement behavior under unchanging pension and social security programs, or to predict the effects of contemplated changes in pension and social security systems, an appropriately specified structural model is required. This discussion has pointed out fundamental deficiencies in the structure of currently available supply side models of retirement behavior.

A principal finding of the descriptive statistics of this paper is that any model which supposes that people are free to reduce hours on their main job as they near retirement age is very substantially at odds with the facts. However, the opposite assumption, that all jobs have minimum hours constraints, is not completely tenable either in view of the fact that around one-third of individuals partially retire at one time or another during their lives. For individuals who do face minimum hours constraints in their main jobs, another route is open to reduce work effort, namely, to take another job, probably at a lower wage, which does not entail this constraint. We have shown that parameter estimates which are made in the context of a complete structural model under the assumption that hours in the main job are freely variable may overstate the elasticity of substitution and/or create biases in the estimates of other parameters in the utility function. An upward bias in estimates of the elasticity of substitution may lead to an overstatement of the sensitivity of hours of work to changes in the parameters of pension and social security programs.[16] Parameter estimates made in the context of a model which ignores the possibilities for partial retirement are also subject to error, but the direction of this error depends on the correlation of the omitted hours constraints with elements shifting the utility function.

More exact answers as to the size of biases involved must await the estimation of a structural model which incorporates explicitly a minimum hours constraint in the main job, at least for a substantial fraction of the population. To estimate such a model, the data problems noted above must be overcome. As noted at the outset, such a model, once estimated, can help to answer a number of important policy related questions about the future course of retirement, the impact of changes in pension and social security programs on retirement behavior, and the substitution of older workers for groups such as women and youth whose labor market opportunities have been of special concern to policy makers.

FOOTNOTES

1. For a recent survey of the relevant literature, see Mitchell and Fields (1982).

2. Pellechio (1981), Burkhauser and Quinn (1981) and others discuss interdependence over time in the budget equation. MaCurdy (1981) discusses relevant aspects of the life cycle utility function.

3. The Gordon-Blinder analysis does not quite provide structural estimated for a complete life-cycle model. They consider a three-period model in which the three periods are "past," "present," and "future." Assuming full-time work in the past, they derive two formulae for the reservation wage in the present, depending on whether or not the individual works in the future. Whether or not the individual works in the future, however, depends on the very parameters they are trying to estimate. Hence, Gordon and Blinder face a bit of the chicken-and-egg problem: the proper reservation wage equation to use for a particular individual depends on the parameter values, but in order to estimate the parameter values, they must already know which equation applies to each individual. In their empirical estimation, Gordon and Blinder sidestep this problem by using a reservation wage equation which is a compromise of the two derived reservation equations, without trying to decide which one is right for particular person. This compromise permits them to derive parameter estimates much more easily than would otherwise be possible, but at an unknown cost in terms of the reliability of those estimates.

4. For a related theoretical analysis, see Burbidge and Robb (1980).

5. It should be recognized throughout this discussion that pension rules, mandatory retirement provisions and even provisions of social security benefits are not exogenous to retirement behavior, although they may be exogenous to the discussions of any particular individual. Early retirement benefits and mandatory retirement provisions have been viewed as outcomes of an employment contract, rather than as exogenous influences on the contractual relation (Lazear, 1979, 1981). The Social Security program is increasingly being influenced by retirement behavior of the growing number of older workers. Moreover, the literature on unions and compensation laws traditionally treated pensions as an outcome of the wage and employment process (Gustman and Segal, 1972 and 1977).

6. One might argue that this observation simply reflects mandatory retirement rules and pension regulations which limit collection of benefits to those who have left the covered job. However, we found that the relative frequency of partial retirement outside of the main job remains high even for those who are not subject to mandatory retirement on their main job, who have no pension in their main job, and who have no health problem. An alternative, but not mutually exclusive explanation for the prevalence of partial retirement outside the main job is that jobs taken outside the main job are much less difficult to perform than are the main jobs and this lower work effort requirement is much more highly valued by older workers.

7. Later waves of the surveys, unavailable to us at the time this paper was written, corrected this defect in the routine pattern of the questionnaire.

8. A similar table for 55-65 year-olds, not reported here, indicated a relation between the two age groups in the disaggregated data comparable to the relation between lines 2 and 3 in Table 1.

9. Survey No. 39, entitled Retirement Policies and Programs.

10. The location of the indifference curves in this diagram depends on the marginal utility of income during the period, which in turn depends on the amount of income earned in other periods, and through that on wage rates and labor supply decisions in other periods. This dependence of the indifference curves on the individual's marginal utility of income is the factor that renders this income-leisure diagram invalid as the sole tool for the analysis of retirement behavior.

11. The fixed hours model simply adds the additional constraint $L(t)[1 - L(t)] = 0$ to the previous model. An alternative way to formulate this model is to hypothesize that the individual maximizes $U = u(Y, R)$ subject to the budget constraint $Y = A_0 + \int_0^{N-R} W(t)dt$ where Y is income, R is year of retirement, N is the lifetime, and other variables are as defined before.

12. For a discussion of the variation over the life cycle in wages for work in the primary job and for work while partially retired, see Gustman and Steinmeier (1982). Implications of partial retirement for wage profiles as conventionally estimated are also discussed in that paper.

13. At each point in time, consumption along an optimal path must satisfy the relationship $u_C[C(t), L(t), t] = ke^{-rt}$, where u_C is the partial derivative or u with respect to consumption and k is a constant which may be interpreted as the marginal utility of discounted lifetime

income. With the condition given in the text, it may be shown that for a constant k, the value of C(t) which satisfies this equation at any point in time is positively related to L(t). Thus for a given value of k (MU_Y), work (and therefore income) would be greater along the dashed path under the hypothesis that time B precedes time A, and consumption would be lower.

14. The fact that the individual chooses leisure along the solid path between time B and time A implies that $u[C_1(t), 1, t] - ke^{-rt}C_1(t) > u[C_0(t), 0, t] + ke^{-rt}[W(t) - C_0(t)]$, where C_1 is the amount consumed when leisure is chosen and C_0 is consumption when full-time work is chosen, and where $C_1(t)$ satisfies the equation in the previous footnote for the given t. Using the condition given in the text, it can be shown that this relationship continues to hold for lower values of k. Hence, between time B and time A, a lower value of k along the dashed path cannot induce the individual to switch from complete retirement to full-time work.

15. Remember that, according to the model being analyzed, indifference curve II is assumed by the investigator to be associated with full-time work.

[16]Errors in measuring the wage offer variable, errors which are traceable to misspecification of the opportunity set from ignoring partial retirement, may create a bias in the opposite direction. For a discussion, see Gustman and Steinmeier (1982).

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Table 1

Probability That Time at Work Cannot Be Reduced[a]

	(1) Cannot Reduce Hours	(2) Can Reduce Hours	(3) Not Ascertained	(4) (1)/[(1)+(2)]
25-55 year-olds	.41	.32	.27	.56
25-55 year-olds usually working $\leq$ 42 hours/week	.41	.26	.34	.61
55-65 year-olds usually working $\leq$ 42 hours/week	.45	.27	.29	.63
25-55 year-olds covered by a pension	.42	.32	.26	.57
25-55 year-olds who are union members	.34	.33	.34	.51

[a]Data are from the Panel Study of Income Dynamics, 1971-1975. Sample includes males who were not self-employed.

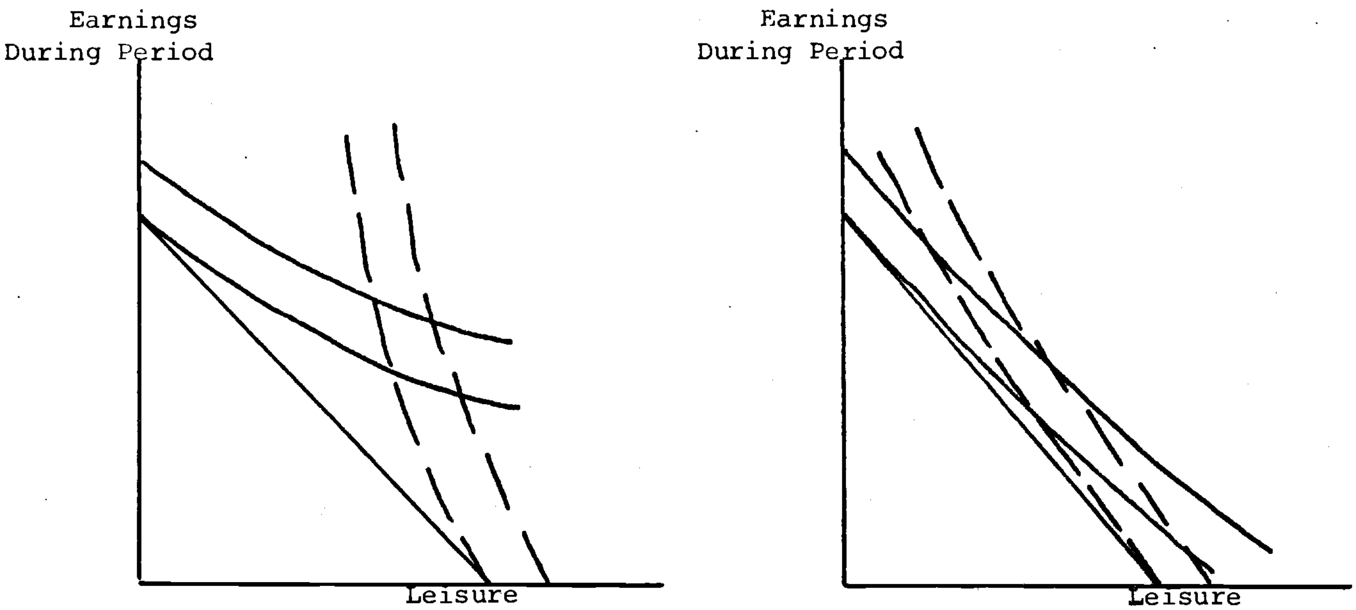
Table 2: Probability that Time at Work Cannot Be Reduced, by Occupation and Industry[a]

	(1) Cannot Reduce Hours	(2) Can Reduce Hours	(3) Not Ascertained	(4) (1)/((1)+(2))
By Occupation				
Professional, Technical, and Kindred	.47	.40	.12	.54
Managers, Officials, Proprietors	.46	.48	.06	.49
Clerical and Sales	.42	.31	.26	.58
Craftsmen, Foremen, and Kindred	.35	.35	.29	.50
Operatives	.38	.26	.37	.59
Laborers	.37	.23	.39	.62
Total (including NEC)	.41	.32	.27	.56
By Industry				
Agriculture	.40	.25	.35	.62
Mining	.31	.42	.27	.42
Metals	.32	.33	.35	.49
Machinery, Incl. Elec.	.40	.37	.23	.52
Motor Vehicles	.36	.29	.35	.55
Other Durables	.37	.33	.30	.53
Food	.43	.22	.34	.66
Tobacco	.44	.26	.30	.63
Textiles, Apparel and Shoes	.43	.23	.33	.65

Paper	.29	.39	.31	.43
Chemicals, Petroleum, Rubber and Plastic	.41	.29	.28	.59
Other Nondurables	.44	.26	.29	.63
Construction	.32	.29	.38	.52
Transportation	.33	.39	.27	.46
Communication	.37	.41	.22	.47
Other Public Utilities	.43	.31	.26	.58
Retail	.43	.36	.21	.54
Wholesale	.38	.39	.23	.49
Finance, Insurance, and Real Estate	.47	.35	.17	.57
Repair Services	.34	.37	.28	.48
Business Services	.45	.22	.33	.67
Personal Services	.31	.35	.35	.47
Amusement	.39	.37	.23	.51
Printing	.46	.29	.25	.61
Medical	.54	.23	.23	.70
Education	.44	.38	.18	.54
Professional Other than Medical or Education	.42	.40	.18	.51
Army	.60	.25	.16	.71
Government	.48	.28	.23	.63
Total Incl. NEC.	.41	.32	.27	.56

[a]See footnote to Table 1.

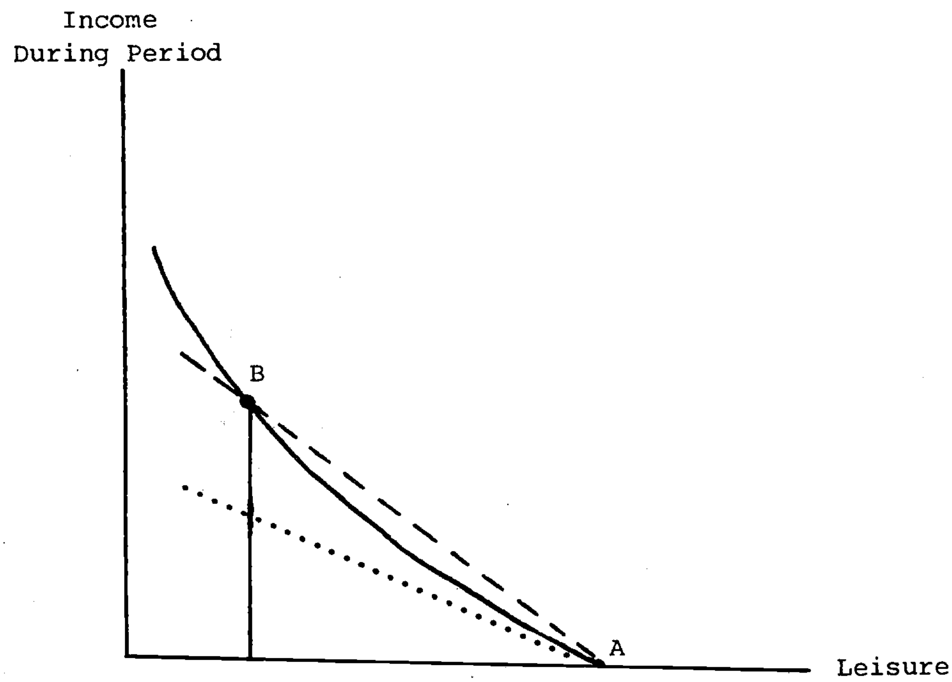
Figure 1. Alternative Explanations for a Sudden Transition Between Full-Time Work and Retirement.



(a) (b)

Legend: Indifference Curves in Period Before Retirement ________
Indifference Curves in Period After Retirement ____ ____

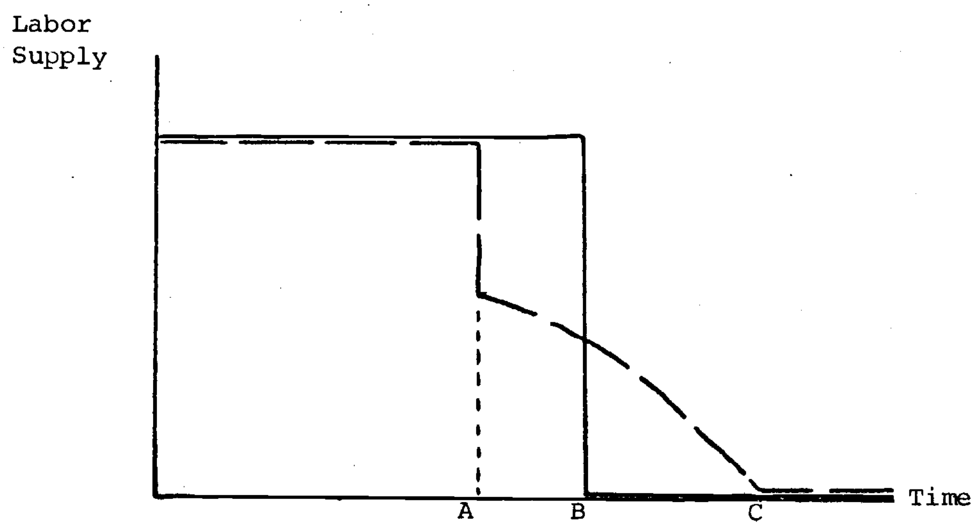
Figure 2. Reservation Wages with and without Minimun Hours Constraint



Legend: ········ Reservation Wage with no minimum Hours Constraint

— — Reservation Wage with a Minimum Hours Constraint

Figure 3. Labor Supply with and without a Second Job Lacking a Fixed Hours Constraint



Legend: Labor Supply with Single Job with Fixed Hours ____________

Labor Supply with Two Jobs, One with Fixed Hours ______ ______

Figure 4. Potential Bias Arising From the Failure to Consider a Partial Retirement Job