A Model Of Desired Wealth At Retirement

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This paper illustrates and executes a strategy for estimating the amount of wealth at which a person will retire. The concept of permanent income is used to frame the retirement decision as one where you retire when your full wealth can afford you your desired consumption. Recently retired individuals from the 1983, 1986 and 1989 Survey of Consumer Finances are used to predict what observable characteristics in a household determine this threshold, or "reservation" wealth level. These estimations include several simulations.

Key Words*: Life-cycle model, Labor-force participation, Retirement, Survey of Consumer Finances, Wealth*

Section 1: Introduction

One of the primary goals in financial planning and education is to help determine how much wealth an individual or household needs to feel comfortable in retirement. This paper uses a strategy common to estimating reservation wages (the minimum wage at which an individual will enter the labor force) to estimate the determinants of *desired wealth at retirement* (the minimum wealth level at which an individual will retire). While some have attempted to determine a rational level of consumption at retirement (e.g., Hanna, Fan & Chang, 1995), this article attempts to estimate the amount with which people *actually* retire, based on the behavior of individuals in a micro-data set.

Previous economic literature has framed the retirement decision as one where you work as long as the marginal benefit of working another year is greater than the marginal costs of working another year. Quinn (1977) was one of the first to test a model of voluntary retirement. Quinn found ambiguous results for the effects of the economic situation on retirement. Quinn did find that Social Security and pension eligibility increased the probability of being retired, and that individuals with a higher wage rate retired later than otherwise similar individuals with a lower wage rate. But Quinn's main conclusion was that an individual's health status played a more important role in determining working status than any of the other effects. Burkhauser (1979) improved upon Quinn's modeling by observing that it was changes in wealth over time, not the levels of wealth at a certain period that should determine retirement status. Burkhauser then demonstrated that individuals with more to gain from working another year (i.e. those who expect to accrue large Social Security or pension wealth in the next year) tend to retire later, and that these effects in fact tend to outweigh health effects. Fields and Mitchell (1984) used a dichotomous choice model to confirm many of Burkhauser's assertions. All of these studies demonstrated how pensions and Social Security can encourage workers to retire at prescribed ages by altering the implicit wages that workers receive, and by manipulating the "unearned" income to which workers are entitled over time (Ippolito, 1990).

One major limitation of previous empirical work, however, is that it ignores the inherent endogeneity of most unearned income measures -- in other words, an individual may have control over the amounts. Previous studies used pension and Social Security entitlements in a given year to explain retirement age or probability of retirement. But since past entitlements are endogenous, and furthermore are determined by past labor force participation, empirical analyses in this vein can lead to simultaneous equations bias.

This article will attempt to resolve this issue by modeling the endogenous nature of wealth explicitly. The concept of permanent income is used to frame the retirement decision as one where a worker retires when the full wealth of the household affords it enough per-period income to retire, based on the subjective consumption needs of the household in question. As with previous models, the assumption here is that retirement is completely voluntary, and that individuals do not get utility from work (other than monetary compensation).

The next section illustrates how the permanent income

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hypothesis implies a level of potential income (defined similarly to permanent income) at which someone is indifferent between work and retirement, called reservation wealth. If your potential income (what your full wealth can afford in terms of permanent income) is less than your reservation wealth (what you need to retire), then you work. If potential income is greater than reservation wealth, then you retire. Section 3 uses economic theory to determine how reservation wealth is related to various relevant household characteristics. Section 4 is a strategy for estimating reservation wealth, and Section 5 provides some evidence from the Survey of Consumer Finances. Section 6 provides a summary.

Section 2: Conceptual Model

Perhaps the most important contribution of this article is its assertion that the retirement decision is not simply a problem of comparing the costs and benefits of spending another year at work, but is also a problem of financing consumption while not working. In this way, it is very much a corollary to the permanent income hypothesis (Friedman, 1957) and the life-cycle model of saving (Ando & Modigliani, 1963). An explicit example of the essence of these two theories, offered by Zorn and Gerner (1986), is shown here. In this example, full wealth at time t is expressed in terms of the initial assets at time t and present value of future earnings.

$$FW_t = NW_t + \sum_{i=t}^{t+T} \frac{Income_i}{(1+r)^i} \qquad (1)$$

where FW_t is full wealth at time t, NW_t is net worth at time t, $Income_t$ is non-investment income in time t, r is the interest rate, and T is life expectancy. It will be important here for us to conceptualize *full wealth* as all assets and liabilities for which the individual has legal claim. This would include all pension rights, etc. that are entitled, even if they occur at some time past t. Permanent income, then, would be defined as follows:

$$\Pi_t = FW_t \frac{r}{1 - \frac{1}{(1+r)^{T+1}}} \qquad (2)$$

where $\prod_t$ = Permanent Income at time t. The part of Equation 2 to the right of full wealth is simply an annuity factor, which calculates how much potential income could be generated by full wealth, given a length of life T. In Ando and Modigliani's notation, this was simply called $\Omega(t)$. Friedman's hypothesis was that consumption at time t did not depend upon income at time t but on permanent income at time t.

If you believe the permanent income hypothesis, then you must also believe that for someone who voluntarily exits the labor force, permanent income at time t must equal full wealth at time t, divided by the annuity factor Ω. The retirement decision framed in this manner is one where the worker is constantly observing the income level which their full wealth could afford them over their lifetime. In a world where life expectancy and real interest rates are deterministic, this potential income for a household, V, is the following:

$$V = \frac{NW_t}{1 - \frac{1}{(1+r)^m} + b\left[1 - \frac{\frac{1}{(1+r)^w}}{\frac{r}{(1+r)^m}}\right]} \qquad (3)$$

where V = potential income, b = 0 if the household in question is made up of a single individual, b = the 1 to 2 person cost of living if the household is made up of a married couple; m = life expectancy of the individual if the household is a single individual, m = the expected length of marriage if the household is a married couple; and w = 0 if the household is a single individual, w = expected length of widowhood if the household is made up of a married couple.[a] Equation 2 is essentially a special case of Equation 3 when the household is a single individual.[b] This V can be interpreted as Friedman's permanent income, contingent upon never working again. While potential income V is actually a stock, it is measured in terms of its flow value. Potential income represents the flow of income that one's stock of full wealth could afford, given prices, life expectancy, and interest rates. Once permanent income contingent upon retiring reaches the desired consumption level, an individual will retire. Permanent income will now be called reservation wealth, or reservation V; it is the amount of potential income (or V, as defined in Equation 3) where the individual is indifferent between working and retiring.

One way to interpret potential income and reservation

wealth is in terms of supply and demand. Potential income is observable; it is the "supply of wealth" to which a person has access. Reservation wealth can be thought of as *the demand for wealth*, since it is this hypothetical potential income level at which an individual decides to no longer work. Reservation wealth is the solution to the thought process "If I had X dollars per year for the rest of my life, guaranteed, I would retire." Retirement occurs when potential income (supply) equals reservation wealth (demand). Although both Friedman and Ando and Modigliani essentially ignored labor supply decisions, it is clear from the reasoning above, as well as from Equations 1 and 2, that reservation wealth is determined by labor and leisure preferences. In fact, economic theory, together with many of the results from past literature in the economics of retirement, will help us frame a strategy for estimating reservation wealth for an individual or a household. This is the purpose of the next section.

Section 3: Theoretical Analysis

Economic theory can be used to generate several hypotheses regarding the determinants of an individual's reservation wealth. Imagine someone deciding how many hours of total time, T, to allocate towards leisure, L (this would make the amount of time working equal to T-L). One hour of leisure has an opportunity cost of the hourly wage, W, since one gives up $W for spending an hour of time in leisure. Working, however, earns income (again, $W for every hour of work), which can be used purchase consumption at price P. Reservation wealth V* is the level of hypothetical unearned income such that the person would decide to work exactly zero hours.[c]

Unfortunately for this individual model, assets are usually pooled within the household. The dynamics of dual decision makers need to be incorporated into the model if the household consists of a married couple with shared wealth but individual labor force participation. The easiest way to incorporate two people into the model is to assume that each individual treats the spouse's income as unearned.[d]

This two-person static model generates an additional hypothesis regarding the effect of someone's market and non-market characteristics on their spouse's reservation wealth. The higher your spouse's wage, the lower your reservation wealth. This would mean, for instance, that if your spouse got a job promotion which paid a higher wage, it would most likely increase your spouse's reservation wealth (because it increased his/her wage) and decrease your own reservation wealth, thereby pulling your anticipated retirement dates away from each other. Couples with larger earnings differentials would therefore expect to retire at longer differences in time.

Shared Time This above two person static model, of course, completely ignores the dynamics of what goes on in the home. The results are essentially telling a division of labor story: the more different the market characteristics of the spouses, the greater the advantage to specialization - the high wage earner chooses to work longer while the lower wage earner simultaneously decides that the spouse's increased work effort will provide sufficient consumption to stop working. This result is based upon the fact, however, that the two individual's quality of leisure time is unaffected by whether their spouse is working or not. A family utility model, where the family gets utility from consumption and each household member's leisure, could tell a slightly different story. Consider a model which differentiates between leisure time spent alone and leisure time spent by the couple together (for an example of this type of model, see Bryant and Wang, 1990).[e]

In general, anything that determines labor supply also determines reservation wealth. We could therefore write an equation that characterizes reservation wealth, or V*.

$$V_i^* (NW_i^*, r, T_i) = \beta Z_i + \epsilon_i \qquad (4)$$

where Z is a set of present and future characteristics that determine reservation wealth.

Section 4: Procedures

We cannot observe reservation wealth, but we know that for those who have recently retired, reservation wealth is approximately equal to actual wealth. Therefore, reservation wealth is observed for a sample of recently retired individuals, and sample selection issues arise only to the extent that not everyone retires and some retire more than once.

Data were collected from the 1983, 1986, and 1989 Federal Reserve's Survey of Consumer Finances (SCF), which is a survey designed to collect detailed information on household's assets and liabilities. There were very few differences between how the surveys were taken, the main two being that 1986 interviews were taken by phone (1983 & 1989 were conducted person-to-person) and the 1989 SCF used a multiple imputation procedure for non-responses (1983 and 1986 used single

imputation).[f]

Since the unit of observation is the household, we will be estimating household reservation wealth. This estimation will correspond precisely to our previous theory only in the case of a single individual household. The sample consists of all households from the three sub-samples where all the household members were either retired, a homemaker, or disabled, and at least one member had retired in the year the sample was taken or before. Retired here is defined as not working more than 500 hours per year, and no intention of working full-time in the future. Also, the oldest member of the household (household member defined as either the head or the spouse) was between the ages of 50 and 79. All respondents from the three surveys who fit the above criterion were grouped into one large cross-section. There were 71, 35 and 42.2 married households from the 1983, 1986 and 1989 SCF and 19, 15, and 15 single households from those surveys, respectively.[g]

Full wealth is calculated for each household by adding all assets (bank accounts, securities, insurance, real estate, family business, vehicles, other valuables, and the present value of pension and Social Security contingent claims) and subtracting all liabilities (mortgages, credit cards, notes, other debt). For all present value calculations, a 6% inflation rate and a 2% real rate of interest is assumed. A 4% real interest rate was used as well, but the results were not particularly sensitive to this difference. Social Security estimates were taken using the current rules and projecting each household's expected benefits for each period in which they were expected to be still alive. Defined benefit pension amounts were calculated in a similar manner, based on the expectations of respondents. If the first spouse to die has a pension or Social Security which pays a survivor benefit, then it is assumed that the amount of that benefit is paid to the widow in each time period between the pensioner's death and the widow's death.

Life expectancy was calculated using the 1988 Vital Statistics of the United States age and gender information, so that V (potential income) can be calculated for all households in the sample. This potential income level (which is our proxy for reservation wealth) is then regressed on the relevant characteristics of the household. These characteristics are the wages of the household members, whether the person is employed in a "white collar" occupation, their self-reported health status, education levels, ages, and the number of dependents (other than the head or a spouse, if one exists) in the household. This is essentially an ordinary least squares estimation of Equation 4 in section 3 - regressing reservation wealth on everything we think might determine it.

Section 5: Results

Table 1 gives the reservation wealth estimates for married couples, differentiating between the male and female member's characteristics, and Table 2 gives the results for the single households (a more detailed description of all the variables used is found in the Appendix.) There are several key points to note. Among married couples, all the signs on the variables are what labor supply theory predicts. One criticism of these results is that many of these estimates are not statistically significant. While this is true, one must remember that the small sample size means that the power of the t-test is quite small, which means that the low t-values do not confirm that these variables are not related to wealth at retirement. Another critique is that because the model is assuming that all of the right hand side variables are exogenously determined, perhaps these estimates are simply describing the correlates of potential income in the population, and not necessarily capturing any retirement decision-making criterion. For example, when one runs the same regression with all households in the 1989 SCF, one finds very similar results - wages, being a white-collar worker, being in good health, and education all are positively correlated with full wealth. One can no longer say for the entire sample that potential income is a proxy for reservation wealth; this regression simply tells you how wealth is correlated with the right-hand-side variables. The only result from using the entire sample and using the sub-sample of retirees is with respect to the result on the number of dependents; in the general population, having dependents is correlated with lower wealth, all other things equal. Yet among retirees, the number of dependents is positively correlated with wealth, as the reservation wealth theory predicts. This is some evidence that these regressions are not simply illustrating the correlates of full wealth in the total population, but something having to do with income needs in retirement.

The Table 2 results for single individuals yield similar results to the married couples with respect to wages, occupation, health status and education, although the standard errors are even higher now that we have an even smaller sample. The result with respect to the sex of the household is noteworthy. This positive coefficient suggests that, on average, women are retiring with more per-period potential income than men. As with the result

on dependents in Table 1, this is the opposite of what you would find in the general population, since single men tend to have more wealth than single women and women's longer life expectancies would translate into even less in terms of potential income. What this could mean is that single women actually have higher income needs in retirement than single men. Unfortunately, the result with respect to dependents is negative in this regression, suggesting that this may be just picking up the correlation in the population between full wealth and dependents.

Table 1
Reservation Wealth Estimates for Married Couples. Dependent Variable: Reservation Wealth (Potential Income at Retirement.)

Variable	Parameter	t values
Male's most recent hourly market wage in dollars	561.03	10.728*
Male ever employed in professional/managerial occupation	6783.65	1.554
Male reports poor health	-2107.26	-0.537
Male's years of education	323.42	0.571
Male's age	853.80	2.104*
Female's most recent hourly market wage in dollars	127.68	0.489
Female ever employed in professional/managerial occupation	965.65	0.198
Female reports poor health	-3548.27	-0.839
Male's years of education	3683.60	3.956*
Female's age	131.60	0.348
Number in household in addition to couple	2009.10	0.618
Intercept	-94787	3.794*

F=7.84. (n = 148) R^2 = 0.3863, Adjusted R^2 =0.3370
* significant at the 5% level

Table 2
Reservation Wealth Estimates for Singles. Dependent Variable: Reservation Wealth (Potential Income at Retirement.)

	Coefficient	t values
Most recent hourly wage in $	467.97	2.289*
Ever employed in managerial/professional occupation	6568.27	0.992
Reports poor health	-8549.13	-1.532
Years of education	1895.13	1.861*
Age in years	796.90	1.322
Female dummy variable	1191.08	0.192
Number of dependents	-1104.73	-0.219
Intercept	-60820	-1.456

F=5.801 (n = 49) R^2 =0.4976, Adjusted R^2 =0.4118
* significant at the 5% level

Table 3 gives some simulations of hypothetical households and what it would take to get them to retire, based on the estimates in Tables 1 and 2.

Table 3
Simulation Results.

	Examples		
	A	B	C
Male wage (hrly)	$35.00	$10.00	---
Male is white collar	Yes	No	---
Male in poor health	No	Yes	---
Male's yrs education	18	12	---
Male's age	58	66	---
Female's wage (hrly)	---	$12.50	$15.00
Female white collar	---	No	No
Female in poor health	No	Yes	No
Female's yrs educ.	15	15	14
Female's age	52	64	64
Dependents	1	0	1
Results			
Estimated V* (household's expected per-period income from full wealth)	$45,249	$30,662	$23,760
E(Marriage/life)	21 years	14 years	20 years
E(Widowhood)	12	7	---
Estimated full wealth (NW*)	$1,019,945	$490,389	$388,509

Example A is a hypothetical, relatively well-educated, relatively high-income, one-earner couple with one dependent. Given that the male's full time earnings are around $70,000 per year, the model from Table 1 estimates that it would require $45,000 per year to induce them to retire, which translates into around $1.02 million when you account for the couple's life expectancies. Example B is a couple in their 60's with no dependents and where only the female has any education past high school. Both are assumed to be in poor health, and total earnings if both worked full-time would be around $35,000. The model from Table 1 estimates their desired wealth at retirement at around $31,000, which would translate into $490,000 of full wealth. Finally, Example C is a hypothetical single female in her sixties with some post-secondary education, good health status, 1 dependent, and full-time earnings of $30,000. The model from Table 2 predicts that she would have a desired wealth level of around $24,000 per year, translating into about $388,000 in full wealth.

These estimates might seem on the high side, but one must keep in mind that they include virtually all types of

contingent claims, including Social Security, pension, and house value. The advantage of these simulations is that if you believe the reservation wealth/ permanent income story, then you like the fact that desired per-period income is smaller than full-time earnings, but not too much smaller, as economic theory and economic intuition would predict, respectively. One also sees that the proportion of desired potential income to full time earnings increases as full-time earnings decrease. While this is probably a shortcoming of the estimates, it may also be picking up the fact that bequest motives get larger with permanent income, an empirical result which the permanent income hypothesis neither predicted nor explained.

Section 6: Summary

If in fact there is such a thing as reservation wealth, then our estimates provide some evidence that households' reservation wealth levels differ systematically in the ways in which economic theory would predict. This finding should suggest that the real benefits of the reservation wealth construct will ultimately lie in the model's ability to generate simulations regarding how much a household would need before members voluntarily exit the labor force. Future research in this area should continue to concentrate on what empirical findings on reservation wealth mean in terms of a household's financial situation at retirement.

There are some major limitations of this study which need to be addressed in future research to make simulations such as the one on Table 3 even more useful to financial planners and educators. First, household reservation wealth was estimated, while the theory which motivated the idea was of an individual decision maker. More insight into how one family member's characteristics influence another's behavior could be looked into with greater detail if the unit of observation was the individual and not the household. Another limitation is the small sample size. In addition to a larger data set, a strategy for estimating reservation wealth using both worker's and retiree's information, similar to Heckman's strategy for estimating reservation wages, might be possible (Heckman, 1974). A strategy such as this one could also include an econometric strategy for separating the effects of certain characteristics from the effects of reservation wealth. Another area for future research would be to test the premises of the reservation wealth model with consumption data, especially since the underlying hypothesis of the reservation wealth model is that households save for retirement to maintain a desired consumption level. Nevertheless, this paper has given us a first look into desired consumption levels of recently retired households.

Appendix

Description of Variables

Continuous Variables

Variable	Description	Mean (Std Dev)	Min Max
Wealth/ period (V) (Married)	In 1989 Dollars; The household's expected per-period income from full wealth	27,939 (39,795)	6,574 1,962,889
WEALTH (V) (Single)	In 1989 Dollars; The individual's expected per-period income from full wealth	14,259 (30, 960)	1656.23 939,289
Male wage rate	For married households; the male's most recent hourly market wage in dollars	20.17 (21.20)	3.59 - 1270.00
Female wage rate	For married households; the female's most recent hourly market wage in dollars (=0 of never worked)	8.38 (8.46)	0 - 40.11
Wage rate	For single households; the most recent hourly market wage in dollars	12.71 (17.56)	2.12 - 145.25
Husband's education	For married households; years of formal education for the male	11.73 (4.11)	0 - 17
Wife's education	For married households; years of formal education for the female	11.62 (3.76)	4 - 17
Education	For single households; the years of formal education	11.08 (5.24)	5- 17
Male age	For married households' male's age at time of survey, in years	64.00 (5.47)	48 - 79
Female age	for married households; female's age at time of survey, in years	61.25 (6.19)	34 - 77
Age	for single households; age at time of survey in years	63.69 (3.76)	55 - 78

Discrete Variables

Variable	Description	Weighted Frequency
Male white collar	For married households; =1 if male is ever employed in professional/managerial occupation =0 otherwise	0 - 95.41 1 - 52.79
Female white collar	For married households; =1 if female is ever employed in professional/managerial occupation = 0 otherwise	0 - 116.6 1- 31.6
White collar	For single households; =1 if ever employed in professional/managerial occupation =0 otherwise	0 - 38.06 1 - 10.94
Male poor health	For married households; =1 if male reports poor health =0 otherwise	0 - 88.37 1- 59.83
Female poor health	For married households; =1 if female reports poor health =0 otherwise	0- 107.02 1- 41.18
Poor health	For single households; =1 if reports poor health =0 otherwise	0 - 24.44 1- 24.56
Poor health	For single households; =1 if householder is female =0 otherwise	0 - 34.70 1 - 14.30
Number of dependents (Married)	For married households; number of household members besides the head and spouse	0 - 138.27 1 - 3.11 2 - 5.19 3 - .74 4 - .89
Number of dependents (Single)	For single households; number of household members =0 besides head	0 - 44.71 1 - .98 2 - 3.32

Endnotes

a. *This is an over-simplification of joint life expectancy.*

b. *For more on strategies for estimating "V" in a world where life expectancy, prices, and interest rates are random, see Hatcher (1997).*

c. *V* can be derived more formally using a Cobb-Douglas Utility specification as an example:*

$$U(C,L) = C^{\alpha}L^{1-\alpha} \qquad (E1)$$

where α is a utility parameter Maximizing this function subject to the constraint PC = W(T—L) + V gives the following demand functions for leisure and consumption, assuming that the solution is interior.

$$L^{*} = \frac{(WT + V)(1 - \alpha)}{W} \qquad (E2)$$

$$C^{*} = \frac{(WT + V)\alpha}{P} \qquad (E3)$$

The answer to the question "How large does V have to be to get this person not to work?" can be figured out either by setting L = T and solving for V in Equation E2, or setting C* = V/P in the equation E3 and solving for V. Either way, you get the following result:*

$$V^{*} = WT\frac{\alpha}{1-\alpha} \qquad (E4)$$

In this simple static model, a person's reservation wealth depends on that person's wage, and the person's relative preference between consumption and leisure. Therefore, we can expect reservation wealth to be positively correlated with wages, and the larger the role consumption plays in one's personal satisfaction. Even though the model requires that one gets no satisfaction from working (only the consumption which it brings), one could interpret Equation E4 to mean that those who find their job less satisfying would have a lower reservation wealth.

d. *A model such as this looks like the following maximization problem in Cobb-Douglas form:*

Max $U_o(C, L_o)$ =

$C^{\alpha}L_o^{\beta o}$ subject to PC = $W_o(T—L_o)+W_s(T—L_s)$ + V (E5)

where o subscripts denote the characteristics of the utility maximizer, s denotes the characteristics of the spouse. L_s is determined simultaneously from the analogous maximization decision

Max $U_s(C, L_s)$=

$C^{\alpha}L_s^{\beta s}$ subject to PC = $W_s(T—L_s)+W_o(T—L_o)$ + V (E6)

Leisure demanded by the first individual (own) can be solved by first solving for his/her spouse, taking one's leisure as given, then plugging that equation into the first constraint under L_s. This gives you the Nash equilibrium leisure demand curve for the first individual. Setting this leisure demand curve equal to total time and solving for V yields the following:

$$V* = \frac{T\alpha_o - W_s T\beta_o + \frac{W_s T\beta_s\beta_o}{\alpha_s + \beta_s}}{\frac{\beta_s\beta_o}{\alpha_s + \beta_s} + \beta_o} \qquad (E7)$$

The main comparative static that can be found from this equation is that taking the derivative of this equation with respect to the spouse's wage W_s and the spouse's leisure parameter α_s is unambiguously negative, while the derivative with respect to your own wage W_o and own leisure parameter ,α_o is positive, like the single individual case

e. *Since there is an added time use in the model, reservation wealth is solved, for each individual, by setting desired leisure equal to total time minus shared time. The Utility Function would look something like:*

$$U(C, L_o, L_s, S) = C^{\alpha} L_o^{\beta_o} L_s^{\beta_s} S^{\theta} \qquad (E8)$$

where C is consumption which costs price p, L_o is leisure time of the first individual as before, which costs the own wage, As is the leisure time of the spouse, which costs the spouse's wage, and shared time, which costs the sum of both individual's wage, as shown by the following budget constraint:

$$PC = W_oT + W_ST—W_oL_o—W_sL_s—W_oS—W_SS \qquad (E9)$$

f. *For details on multiple imputation, see Rubin (1987).*

g. *The fractional household in the 1989 survey arises from the fact that for one recently retired household, hours worked was multiply imputed, and one of the imputations survived the sample criterion while the other four did not.*

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