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**“The Evolution of Private Pensions, the Effects
of Aging, and the Variance in Assets”**

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of Aging, and the Variance in Assets”

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Abstract

The variance in the collectively accumulated assets of a given cohort of individuals is predicted to grow as the cohort ages together over the life-cycle. This variance in assets is attributed to individual differences in risks associated with earnings and asset returns which accumulated over time. Institutions that share risk across individuals, such as Social Security, have been theorized to limit the rate at which this variance in assets grows. This study tests each of these theoretical predictions with empirical evidence by providing the conditions under which these theories can be accepted or rejected, and alternative explanations are offered where discrepancies between theory and evidence exist. The relationship of the variance in assets on age is shown to hold positive and significant for all asset classes except retirement assets. The variance in total assets grows at 1.3 percent per each year of age, while the variance in financial and non-financial assets grow at less than 1 percent per each year of age. The variance in retirement assets linearly decreases with age, declining at a rate of 4.2 percent per each year of age. There is a statistically significant negative relationship of variance in assets on the percentage of defined-benefit holders that holds across all asset classes, while a positive significant relationship holds for the variance in assets on the percentage of defined-contribution holders across all asset classes. A one percent increase in the percentage that hold defined-benefit plans in a given industry decrease the variance in assets by 0.7 percent. As the percentage of defined-contribution holders in a given industry increased by one percent, the variance in assets grows by 0.8 percent. The evidence highlight the importance of the age structure on the dynamics of the relative well-being of individuals, as seen through the variance in assets. The evidence also identifies one particular outcome of the changing retirement landscape in the United States and other developed countries and stresses the importance of the traditional role of Social Security and similar schemes that share risk across individuals.

Outline

Introduction	p. 5
Part I. Intertemporal Choice and the Variance in Assets	
Theoretical Framework	p. 10
Empirical Strategy	p. 14
Data	p. 16
Evidence	p. 19
Part II. Evolution of Private Pensions and the Variance in Assets	
Theoretical Framework	p. 22
Empirical Strategy	p. 26
Data	p. 27
Evidence	p. 29
Conclusions	p. 32
References	p. 34
Figures	p. 37
Tables	p. 47

Introduction

The variance in the collectively accumulated assets of a given cohort of individuals is predicted to grow as the cohort ages together over the life-cycle (Deaton and Paxson, 1994; Deaton, Gourinchas, and Paxson, 2002). A good portion of this variance can be attributed to differences in individual risk in earnings and asset returns, the effects of which accumulate over the life-cycle, increasing the inequality within groups of individuals as they age. Deaton and Paxson (1994) established the theoretical framework for the variance in consumption, which was derived from patterns in consumption data from the United States, Britain, and Taiwan and was based on the intertemporal choice framework of Deaton (1992).¹ This framework was expanded to the variance in assets by Deaton, Gourinchas, and Paxson (2002). Where there is more individual risk among a cohort of individuals, there will be more inequality. This is true for the variance in earnings, in consumption, and in assets, as they are all related components within the framework of intertemporal choice. This study will provide the conditions under which these theories are accepted or rejected based on the empirical evidence and offer alternative theoretical explanations where the theory and evidence are not in agreement.

The relative differences in assets between individuals has been studied extensively in the literature (Bernheim, Skinner, and Weinberg, 2001; Lusardi, Skinner, and Venti, 2002; Venti and Wise, 1998, 2001). Bernheim, Skinner, and Weinberg (2001) find evidence that differences in retirement wealth are mainly consistent with rule of thumb, mental accounting, or hyperbolic discounting theories of wealth accumulation. Lusardi, Skinner, and Venti (2002) find that late-life inequality in wealth is large in the United States, and that there are many households that hold little wealth, even a few years away from retirement. Venti and Wise (1998) show that

¹ Deaton (1992) unifies the life-cycle model and permanent income hypothesis as two special cases under a broader framework of intertemporal choice. For more on the life-cycle hypothesis, see Modigliani and Brumberg (1954). For more on the permanent income hypothesis, see Friedman (1957).

there is substantial dispersion in accumulated wealth approaching retirement at all levels of lifetime earnings and that the primary determinant of this dispersion at retirement is the choice to save or to spend while young. Venti and Wise (2001) find that investment choice is not a major determinant of the dispersion in asset accumulation and again that the dispersion must be attributed to differences in the amount that households choose to save. Despite this literature, there is little consensus on how these differences in assets evolve over time in a systematic way. This study offers some of the first empirical evidence that looks at the relationship between the variance in assets and aging directly.

Institutions that share risk across individuals, such as Social Security and private pensions, moderate the transmission of individual risk into inequality (Deaton, Gourinchas, and Paxson, 2002). Both the proposed changes to partially privatize Social Security and the evolution of private pensions cause more exposure of individual risk to each cohort. As risk-sharing decreases, thereby increasing individual risk, a further increase in the variance in assets occurs between individuals within a given cohort. The theoretical framework of Deaton, Gourinchas, and Paxson (2002) uses the example of partially privatized Social Security to show that undoing the risk-sharing nature of the program will further increase the variance in assets.

I argue that, in the context of risk-sharing among individuals, the proposed change in Social Security (of introducing personal accounts) and the evolution of private pensions (toward defined-contribution plans) are theoretically identical changes in risk-sharing. Both systems provide a mechanism for risk-sharing that is being undone, which in turn leads to more individual risk, which produces more variance in assets among a given cohort of individuals. However, it is a fact that private pensions have undergone this risk-sharing change, while Social

Security has not, so only the evolution of private pensions provides the data to empirically test the effects of risk-sharing on individuals.

Over the last quarter of a century, employer-provided private pensions have gone through considerable change in the United States. In general, there has been a substantial decline in the amount of defined-benefit pension plans and an increase in the amount of defined-contribution plans. The amount of defined-benefit plans has declined from 87 percent in 1983 to 44 percent in 1998, while defined-contribution plans have increased from 40 to 79 percent over the same period.² Also during this time, pension coverage and firm offerings have increased, with individual pension coverage for wage and salary workers increasing from 42.6 percent in 1993 to 46.7 percent in 1998, and firm pension offerings increasing from 55.7 to 60.7 percent from 1993 to 1998.³

This evolution of private pensions has transformed the retirement landscape in the United States, most notably, by shifting the risks and decision-making associated with retirement savings and retirement onto the individual. Under defined-benefit plans, the *employer* bears all of the interest rate risk, under-funding risk, and lifespan risk, while the *employee* only faces the risk of plan termination, an early severance, and incentive to retire at the employer's pleasure.⁴ Under defined-contribution plans, the employee bears *all* of these risks, and there is no longer the risk of an early severance. These plans also differ in the control of assets, and thus the decision-making process. In defined-benefit plans, the *employer* controls the investment of the

² These percentages are calculated by Friedberg and Webb (2005) using the Survey of Consumer Finances. These numbers do not add to 100 percent due to persons holding multiple pension plans.

³ These percentages are calculated by Copeland (2000) using the Current Population Survey.

⁴ The individual is partially insured against plan termination by the Pension Benefit Guarantee Corporation.

underlying assets, while in defined-contribution plans, the employer defines the set of choices, but the *employee* is in control of the assets and the investment decisions.⁵

Some of the causes and consequences of this shift in private pensions have been examined recently (Friedberg and Owyang, 2004; Aaronson and Coronado, 2005; Friedberg and Webb, 2005). Friedberg and Owyang (2004) find that a decline in the value of existing jobs relative to new jobs reduces expected match duration, and thus, the appeal of DB pensions. Aaronson and Coronado (2005) determine that aggregate factors explain a large part of the movement, with changes in worker demand, due to evolving workforce characteristics, also contributed notably. On the supply side, they find support for the theory that technical change has reduced the value of DB plans. Friedberg and Webb (2005) find that DC plans, which change age-related incentives, lead workers to retire almost two years later on average than under DB plans. However, none of these studies have specifically looked at the consequences of shifting risk on the variance in assets.

The relationship of the variance in assets and age is shown to hold positive and significant across each functional form specification for all asset classes except retirement assets. The variance in assets seems to rise smoothly between the ages of forty and the lower sixties, which then plateaus during retirement years and sharply increases after the age of eighty. The variance in total assets grows at 1.3 percent per each year of age, while the variance in financial and non-financial assets grow at less than 1 percent per each year of age. The variance in

⁵ These plans differ in other ways as well. In DB plans, the benefit is determined in advance and is paid out in the form of an annuity upon retirement. For the DC plans, the contribution is determined in advance and is paid out in the form of a lump sum upon retirement (which can then be annuitized by the individual). The DB plan encourages longer tenure, earlier retirement, and long-term savings, while the DC plan only acts as a long-term savings vehicle. Under both plan types, contributions are tax-deferred. For the DB plan, the median vesting period is five years and pension wealth accrues late in career. For the DC plan, the median vesting period is zero to two years and pension wealth has a smooth accrual. The DB plan is not portable nor bequeathable, and cannot be borrowed against. Whereas the DC plan is portable and bequeathable and can be borrowed against. In DB plans, the firm bears the administrative and regulatory compliance costs, whereas in DC plans, the firm and the worker share the burden of the administrative and regulatory costs. For a further discussion of these issues, see Friedberg and Owyang (2002).

retirement assets linearly decreases with age, declining at a rate of 4.2 percent per each year of age. Altogether, the variance in assets is shown to increase with the age structure in support of the theory. This evidence highlights the importance of the age structure with regards to the variance in assets amongst individuals, with policy implications abound. This offers insight into the relative well-being of individuals and the changing dynamic of this well-being over the life-cycle.

There is a statistically significant negative relationship of variance in assets on the percentage of defined-benefit holders that holds across all asset classes, while a positive significant relationship holds for the variance in assets on the percentage of defined-contribution holders across all asset classes. The negative relationship for defined-benefit plans and the positive relationship for defined-contribution plans provides evidence for the hypothesis that undoing risk-sharing among individuals does increase the cross-sectional variance in assets among them. A one percent increase in the percentage that hold defined-benefit plans in a given industry decrease the variance in assets by 0.7 percent. As the percentage of defined-contribution holders in a given industry increased by one percent, the variance in assets grows by 0.8 percent. This evidence identifies one particular outcome of the changing retirement landscape in the United States, and other developed countries, and stresses the importance of the traditional role of Social Security and similar schemes that share risk across individuals.

Part I. Intertemporal Choice and the Variance in Assets

Theoretical Framework

The theoretical framework is constructed primarily from Deaton, Gourinchas, and Paxson (2002), with supporting roles from Deaton (1991, 1992), Deaton and Paxson (1994), and the author's own derivations. Suppose the economy is composed of autarkic permanent income consumers, each having an uncertain flow of earnings, where the use of the permanent income hypothesis is for the convenience of closed-form solutions. Their individual utility is maximized through a set of intertemporal preferences defined over consumption in multiple periods:

$$(1) \quad u = V(c_1, c_2, c_3, \dots, c_T)$$

If the general assumption is made that preferences are intertemporally additive, or strongly intertemporally separable, then the above can be rewritten as:

$$(2) \quad u = v_1(c_1) + v_2(c_2) + \dots + v_T(c_T)$$

where each individual period subutility is increasing and concave in its argument. The stock of assets evolves from one period to the next in the asset accumulation identity:

$$(3) \quad A_t = (1+r)(A_{t-1} + y_{t-1} - c_{t-1})$$

For simplification, assume there is only one asset and a constant real interest rate, the later of which is used to avoid using multiple discount factors. The asset accumulation identity can be manipulated to form the intertemporal lifetime budget constraint:

$$(4) \quad \sum_1^T \frac{c_t}{(1+r)^t} = A_1 + \sum_1^T \frac{y_t}{(1+r)^t}$$

which the utility function in eq. (1) is subjected to for maximization. Given the assumptions of certainty equivalence (certain outcomes give the same utility as an actual distribution of expected outcomes), a rate of time preference equal to the constant real interest rate, and an infinite time

horizon, consumption satisfies the permanent income hypothesis rule and is equal to the return on the present value of assets and earnings:

$$(5) \quad c_t = \frac{r}{1+r} A_t + \frac{r}{1+r} \sum_{k=0}^{\infty} \frac{1}{(1+r)^k} E_t(y_{t+k})$$

So, the consumption choices a consumer makes are determined not by current income, but by income expectations over the long-term. The innovation of consumption then follows a martingale:

$$(6) \quad \Delta c_t = \eta_t \equiv \frac{r}{1+r} \sum_{k=0}^{\infty} \frac{1}{(1+r)^k} (E_t - E_{t-1}) y_{t+k}$$

where present consumption equals expected consumption in the next time period.

Savings is defined as the difference of disposable income and consumption:

$$(7) \quad s_t = y_t^d - c_t = \left[\frac{r}{1+r} A_t + y_t \right] - c_t$$

where disposable income is the income gained from capital plus earnings. Savings can then be rewritten in equivalent form of the PIH rule (Campbell 1987):

$$(8) \quad s_t = - \sum_{k=1}^{\infty} \frac{1}{(1+r)^k} E_t \Delta y_{t+k}$$

and subsequently assets are linked to savings by:

$$(9) \quad \Delta A_t = (1+r) s_{t-1}$$

If a stochastic process for earnings is specified, determined by specifying the joint probability distributions of the various random variables:

$$(10) \quad \alpha(L)(y_t - \mu) = \beta(L)\varepsilon_t$$

then we can derive explicit forms for the innovation to consumption (Flavin 1981).

Consumption can now be seen as a random walk:

$$(11) \quad \Delta c_t = \eta_t = \frac{r}{1+r} \frac{\beta \left(\frac{1}{1+r} \right)}{\alpha \left(\frac{1}{1+r} \right)} \varepsilon_t$$

where random changes in a variable at any time follow a pattern independent of previous changes. The autocorrelation properties of the variance of earnings innovation ties it to the variance of consumption innovation.

Inequality can now be shown to increase over time. The simplest case is shown first where earnings are white noise, ε :

$$(12) \quad y_{it} = \mu_i + \varepsilon_{it} = \mu_i + w_t + z_{it}$$

and where μ is the individual-specific mean of earnings, w is a common (macro) component which is i.i.d. over time, and z is an idiosyncratic component (particular to one person). The i subscript is also introduced here. Consumption can now be written as:

$$(13) \quad c_{it} = c_{it-1} + \frac{r}{1+r} (w_t + z_{it})$$

If the components of z are orthogonal to lagged consumption in the cross-section, the cross-sectional variance of consumption can be shown as:

$$(14) \quad \text{var}_t(c) = \text{var}_{t-1}(c) + \frac{\sigma_z^2 r^2}{(1+r)^2} = \text{var}_0(c) + \frac{t \sigma_z^2 r^2}{(1+r)^2}$$

This argument need not hold in every year, but it is true on the average by the martingale property. This shows that consumption inequality increases with age.

For the i.i.d. case, savings and assets can be given by:

$$(15) \quad s_{it} = \frac{\varepsilon_{it}}{1+r}$$

$$(16) \quad A_{it} = A_{it-1} + \varepsilon_{it-1}$$

Because disposable income is the sum of consumption and saving, the change in disposable income satisfies:

$$(17) \quad \Delta y_{it}^d = \frac{r \varepsilon_{it}}{1+r} + \frac{\varepsilon_{it}}{1+r} - \frac{\varepsilon_{it-1}}{1+r} = \varepsilon_{it} - \frac{\varepsilon_{it-1}}{1+r}$$

After some algebra, the variance of disposable income can be written as:

$$(18) \quad \text{var}_t(y^d) = \text{var}_{t-1}(y^d) + \frac{\sigma_z^2 r^2}{(1+r)^2} = \text{var}_0(y^d) + \frac{t \sigma_z^2 r^2}{(1+r)^2}$$

Because the consumption variance is spreading and savings is stationary, the disposable income variance must spread at the same rate as the consumption variance.

The variance of earnings is constant given the stationary assumption, so that:

$$(19) \quad \text{var}_t y = \sigma_\mu^2 + \sigma_z^2 = (\text{constnt})$$

The rate of the spread of the variance in assets is the variance of the idiosyncratic component of the innovation of earnings shown as:

$$(20) \quad \text{var}_t(A) = \text{var}_0(A) + t \sigma_z^2$$

At a real interest rate of 5 percent, the variance of assets grows more than 400 times faster than the rate of the variance of consumption and of disposable income. So from any given starting point, asset inequality among a group of individuals grows much faster than does consumption or disposable income inequality.

If the infinite horizon assumption is relaxed, it makes for a more realistic system. Finitely lived consumers work until age R (retirement) and die at time T . Earnings now drop at retirement. The consequence is that savings, which cover the drop in earnings, is no longer stationary, but integrated of order one, making assets integrated of order two. The spread of inequality in assets is therefore an order of integration higher than the spread of inequality in

consumption and disposable income. In this case, the consumption innovation formula can be rewritten as:

$$(21) \quad \beta_t \Delta c_t = \eta_t = \frac{r}{1+r} \sum_{k=0}^{R-t} \frac{1}{(1+r)^k} (E_t - E_{t-1}) y_{t+k}$$

with the annuity factor given by:

$$(22) \quad \beta_t \equiv 1 - \frac{1}{(1+r)^{(T-t+1)}} = (1+r)\beta_{t-1} - r$$

From the revised consumption innovation, present consumption can be rewritten as:

$$(23) \quad c_t = c_0 + \sum_{s=0}^t \beta_s^{-1} \eta_s$$

So in the i.i.d. case previously considered, the variance in consumption becomes:

$$(24) \quad \text{var}_t(c) = \text{var}_0(c) + \frac{r^2}{(1+r)^2} \sigma_z^2 \sum_{s=0}^t \beta_s^{-2}$$

And thus, the variance in assets can then be rescaled to:

$$(25) \quad \text{var}_t(A) = \text{var}_0(A) + \sigma_z^2 \sum_{s=0}^t \beta_s^{-2}$$

where the added component does not change the innovation of the variance in consumption nor in assets.

Empirical Strategy

The main hypothesis to test is whether the theoretical relationship between the variance in assets and age, as shown in equation (20), is truly positive and significant. The magnitude of this effect and the differences of the effect across cohorts and asset classes are equally as important. Again, age in this relationship represents the portion of the variance that is attributable to the accumulation of the differences in individual risks such as earnings and asset

returns. Also, it will be important to see if the magnitude of this relationship declines as retirement sets in, as shown in equation (25).

A linear functional form is first used for its ease of interpretation. However, the correct functional form for the variance in assets on age is assumed to be non-linear in light of the related relationship of earnings on age (Murphy and Welch, 1990). This correct functional form of the relationship between the variance in assets and age is found to be best fit by the cubic function, through minimizing the Akaike Information Criterion associated with each proposed specification.⁶ A log linear functional fit is also included for the purposes of providing the elasticities associated with this relationship.

The parametric models of the variance in assets as a function of age, through a linear fit, a cubic fit, and a log linear fit, can be viewed as follows:

$$(26) \quad \text{Var}[\log(\text{Assets})]_{it} = \alpha + \beta_1 \text{Age}_{it} + \varphi_t + \varepsilon_{it}$$

$$(27) \quad \text{Var}[\log(\text{Assets})]_{it} = \alpha + \beta_1 \text{Age}_{it} + \beta_2 \text{Age}_{it}^2 + \beta_3 \text{Age}_{it}^3 + \varphi_t + \varepsilon_{it}$$

$$(28) \quad \log[\text{Var}[\log(\text{Assets})]]_{i,t} = \alpha + \beta_1 \text{Age}_{it} + \varphi_t + \varepsilon_{it}$$

where age-year observations are used for the variation with the i subscript referring to the age group and the subscript t referring to the year. A vector of year dummies, φ_t , is included in order to control for occurrences that are not associated with the aging process and are associated with specific years. For example, these controls will take out the effect of macro-related shocks to the variance in assets, such as the increased stock market volatility in the late 1990s and early 2000s. Each functional form specification is run with and without these year dummies.

⁶ I use the local minimum of the AIC calculated for each possible functional form of total assets on age.

Data

This study utilizes the advantages of longitudinal data, in order to be certain that the individuals we are following over time are in fact the same individuals, which would not be the case with cross-sectional data. Issues with longitudinal data availability and quality have been worked out over time, where at present, individuals can be examined over time in great detail. Although the number of time periods is still relatively low in these data, their individual observations are quite large for each available time period. Longitudinal data therefore provide the best format for interpreting individual and cohort behavior.

The main source of data for this study is the Health and Retirement Study: a longitudinal household survey for those over the age of fifty within the United States.⁷ The Health and Retirement Study contains detailed income and asset information on these households, as well as other support information such as employment. In particular, a cleaned subset of the original HRS core data is used, which is known as the RAND HRS data.⁸ This data sample combines seven longitudinal waves of the Health and Retirement Study core data from 1992 to 2004, with one wave every two years.⁹ The RAND HRS data is used for its standardized income and asset definitions, which help with the replication of results. In addition, the RAND HRS data contain imputations of all income and asset types using a consistent method, while the Health and Retirement Study public release imputation method for many income and asset types is a simple hotdeck and is inconsistent across waves.¹⁰

⁷ Health and Retirement Study, public use dataset, 1992-2002. Produced and distributed by the University of Michigan with funding from the National Institute on Aging (grant number NIA U01AG009740). Ann Arbor, MI.

⁸ RAND HRS Data, Version F, May 2006. Produced by the RAND Center for the Study of Aging, with funding from the National Institute on Aging and the Social Security Administration. Santa Monica, CA.

⁹ At the time of this study, the early release data for 2004 is available and has been incorporated in the latest release of the RAND asset and income definitions. However, the weights for 2004 have not been calculated and will only be released with the final release version of the 2004 HRS data, which will be incorporated into the RAND data soon thereafter.

¹⁰ For more information on the RAND imputations, see the RAND HRS Data Documentation, Version F, pp. 24 -32.

Whereas the theoretical framework has derived the variance in assets according to one general asset class, this study will use four aggregate asset classes: total assets, financial assets, non-financial assets, and retirement assets.¹¹ Total assets is defined as the net value of total wealth and is calculated as the sum of all wealth components less all debt. The particular wealth components of total assets include non-financial assets (the value of a primary residence, the value of all mortgages and other home loans on the primary residence, the net value of all other real estate, the net value of vehicles, and the net value of businesses), financial assets (the net value of stocks, mutual funds, and investment trusts, the value of checking, savings, or money market accounts, the value of certificates of deposit, government savings bonds, and T-bills, the net value of bonds and bond funds, the net value of all other savings, and the value of all other debt), and retirement assets (the net value of individual retirement accounts or Keogh accounts). All assets are valued in nominal U.S. dollars.

Assets are listed at the household level in the Health and Retirement Study and are reported by the financial respondent of each household. Therefore, within households with more than one respondent, the amount of household assets listed for each respondent is the same. Because the variance in assets calculations in this study require as many observations as possible in order to be accurate, every respondent in a household is treated separately even though it is the same value of assets for each respondent. These multiple respondents within each household are used for their respective age or cohort calculation, so they are most likely not double-counted in a lot of cases. Also, because assets are recorded at the household level, household level analytical weights are used for the calculations when weights are used at all.

¹¹ The imputed value of private pension wealth and social security wealth are ignored at the moment, but will be incorporated into the definition of total assets and retirement assets in a future version of this study. This is especially important for the retirement assets definition, which only includes the value of IRAs and Keoghs at the moment.

The data are first calculated by the pre-specified age cohorts, of which there are five from 1992 to 2004. The largest cohort is the HRS, made up of individuals born 1931-1941 and aged 51 to 61 in the baseline year of 1992. The Study of Assets and Health Dynamics Among the Oldest Old (AHEAD) cohort is the oldest with individuals born before 1924 and aged 69 or older in 1992. The War Baby (WB) cohort is the youngest, born 1942-1947 and aged 51 to 56 in the baseline year 1998. The children of the depression age (CODA) cohort, was born between 1924 to 1930 and was aged 68 to 74 in the baseline year of 1998. The Early Baby Boomer (EBB) cohort was born between 1948 and 1953 and is aged 51 to 56 in the baseline year of 2004.

Only the HRS cohort spans all seven waves from 1992 to 2004. The AHEAD cohort appears along with the HRS cohort in the 1994 and 1996 observations. The HRS, AHEAD, WB, and CODA cohorts all appear in the 1998, 2000, 2002, and 2004 periods. The EBB cohort joins the other four cohorts in 2004. The variance in the logarithm of total assets for each of these cohorts is calculated with and without using the household weights, with an average number of 6,262 individuals per cohort-year observation. The minimum number of individuals that were used for each cohort-year calculation is 1,913 and the maximum number is 12,452. These calculations are also made for each cohort while limiting the sample to only those individuals who responded in all of the waves that the respective cohort spans, which are done with and without weights.

The variance in the logarithm of assets is then calculated for individuals of each age in each wave by each asset class, using household weights for all calculations. In total, there are 272 age-year observations based on an average of 385 individuals within each age-year observation. The minimal number of individuals for each age-year calculation is cut arbitrarily to a minimum of thirty-five per calculation, in order to eliminate calculations based on a handful

of individuals which raises the integrity of the cross-sectional measure of inequality.¹² The maximum number of individuals per age-year calculation is 962.

Evidence

Each of the four pre-specified age cohorts follow an overall upward trend in the variance in total assets over the 1992-2004 period (Figure 1). This is true of both the younger cohorts (HRS, WB) and the older cohorts (AHEAD, CODA). The younger two cohorts also display an overall variance that is lower than the older two cohorts, which is what should be expected if the variance in assets is growing with age. The HRS and AHEAD trends appear relatively smoother due to their larger overall sample sizes as compared with the trends of the WB and CODA cohorts. The weighted data seem to be on the conservative side of the variance in assets and the rate at which it grows over time, as the variance is on average less with the weights and grows less with the weights. When the sample is limited to those that only responded in all waves, a dramatic increase is seen in the rate at which the variance in assets grows over time, which is especially true of the older two cohorts in the data (AHEAD, CODA), showing the importance of differential attrition in the variance. The analysis proceeds from here using only the household weighted data that is not limited to those who responded in all waves, but the data is now detailed by the separate asset classes.

A steadily increasing linear trend is found in the variance in assets, spanning the ages forty to ninety-five for all of the asset classes except retirement assets (Figure 2). The slope of

¹² The lower this threshold, the more aggregate observations there are for the empirical analysis, but the less accurate are the measurement of the respective variances that make up the observations. An optimization technique can most likely be employed here to find the optimal ratio of individual observations to aggregated observations, similar to what is done to find the optimal bandwidth required for non-parametric kernel methodologies. Another alternative to the arbitrary cutoff method employed at the moment would be to look at the distribution of age-year observations and cut off the lowest 5 percent of observations.

this relationship is smaller for financial assets, while the average variance in assets is much larger for financial assets. This is not surprising given the volatility of markets and the fact that some individuals have little financial assets in their portfolios. Non-financial assets also display an upward sloping relationship of variance in assets on age as well, with much less average variance in assets than financials. The most striking finding with regards to the variance in retirement assets. The variance of retirement assets decreases with age. This result seems to be counterintuitive under the predictions of the theory. One explanation is that individuals begin saving for retirement at different times and at different rates, which keeps the variance in retirement assets relatively high in the ages of the 30s and 40s. As they move along the life-cycle toward retirement, more individuals begin saving for retirement and saving more, so the bottom comes up, reducing the variance among individuals. After retirement, the top will draw down their assets faster than the bottom, reducing the variance further.

The data also seem to display two structural breaks in the age distribution right around the retirement ages in the lower to mid-sixties and again around the age of eighty. That is, the variance in assets seems to rise smoothly between the ages of forty and the lower sixties, which then plateaus during retirement years and sharply increases after the age of eighty. The steadily rise in the variance between the ages of forty and sixty is similar to evidence on the variance in consumption and age (Deaton and Paxson, 1994). This trend in the variance during retirement years will need to be analyzed separately in a later version of this study to know what is exactly happening during this period. However, it can be thought that the variance holds steady during these years due to the end of the run-up in assets prior to retirement. The sharp increase after eighty is most likely due to the difference in the timing of bequests, institutionalization, or death at the end of the life-cycle.

The relationship of the variance in assets on age is shown to hold positive and significant across each asset class and functional form specification, with the exception of those estimates of the variance in retirement assets on age (Table 1). The variance in total assets grows at 1.3 percent per each year of age, while the variance in financial and non-financial assets grow at less than 1 percent per each year of age. If we were to take a group of individuals that are 40 years old and follow them over another 40 years, the variance in assets will have increased by over 50 percent by the time the cohort is age 80. In other words, the variance in total assets of a given cohort roughly doubles in 77 years, a projected lifetime in most cases. Retirement assets decline at a rate of 4.2 percent per each year of age.

Given the correct functional form specification of the cubic fit, the age structure explains away roughly half of the variance in total assets. The estimates for age are slightly lower in magnitude with the inclusion of the year dummies for total assets and financial assets. Note that in the age regressions that control for the year dummies, 1998, 2000, and 2002 (the years of high market volatility in the United States) display a statically significantly positive effect at the five percent level across almost all asset classes. This is due to the removal of the effect of the variance caused by various macro shocks from the measurement of the effect of age.

Altogether, the variance in assets is shown to increase with the age structure in support of the theory. Because the natural logarithm of assets is taken before every variance calculation, only individuals with positive assets are included. Therefore, this study underestimates these effects, as those individuals with non-positive (either zero or negative) assets are ignored. More than five percent of the HRS sample contains individuals with non-positive total assets.

Part II. Evolution of Private Pensions and the Variance in Assets

Theoretical Framework

The following model shows how a risk-sharing system decreases the spread of inequality among individuals in income, consumption, and assets. Again, the theoretical framework is attributed to Deaton, Gourinchas, and Paxson (2002). Though the model shown is based on a system of Social Security, it can alternatively be thought of as a private pension system, in which all of a population is enrolled, that contains a two-part benefit: one that is defined-benefit in nature and one that is defined-contribution in nature. The allocation into each benefit part would have to be set exogenously, like the government would set for Social Security.

Assume the government enacts a simplified social security system, with a proportionate tax on earnings, τ , and with revenues divided equally and given to everyone. Earnings, with a Social Security tax, is derived in the forms:

$$(29) \quad y_{it} = (1 - \tau)(\mu_i + \varepsilon_{it}) + \tau\bar{\mu}$$

$$(30) \quad y_{it} = \mu_i - \tau(\mu_i - \bar{\mu}) + (1 - \tau)\varepsilon_{it}$$

$$(31) \quad y_{it} = \mu_i - \tau(\mu_i - \bar{\mu}) + (1 - \tau)z_{it} + w_t$$

where τ is introduced to the same form of earnings as in eq. (12) within Part I. The last term, $\tau\bar{\mu}$, is the average revenue of the tax which is redistributed to each individual. Compared with the original earnings process, there is now a shift toward the grand mean, the redistributive effect of Social Security. This is done together with a rescaling of the innovation by $(1 - \tau)$, the risk-sharing component of Social Security. This redistribution will change consumption levels for everyone not at the mean, but will not effect the innovation of the variance equations (14, 18-20) within Part I, except to rescale them by $(1 - \tau)$, which has them each evolve at $(1 - \tau)^2$ the original rate. Assets for example now take the form:

$$(32) \quad \text{var}_t(A) = \text{var}_0(A) + t\sigma_z^2(1-\tau)^2$$

For example, if the tax is set at 12.4 percent, inequality (as measured by variance) will spread at 76.7 percent of the original rate. The common (macro) component, w_t , is not insured against, which makes the modified change in consumption:

$$(33) \quad \Delta c_{it} = \frac{r}{1+r} [w_t + (1-\tau)z_{it}]$$

where only the second term in the bracket contributes to the spread in the variance of consumption. This makes after-tax earnings while working:

$$(34) \quad y_{it} = (1-\tau)(\mu_i + \varepsilon_{it}) = (1-\tau)\mu_i + (1-\tau)(w_t + z_{it})$$

for finitely lived individuals. Given a uniform distribution of ages, the benefits received while retired in year $R+s$ are:

$$(35) \quad \frac{R\tau(\mu + w_{R+s})}{T-R}$$

This shows that with certainty equivalence, only the expected value matters, which is constant given the i.i.d. assumption. So although the levels of consumptions are altered, there is no change to the innovation of consumption, nor at the rate in which the various inequality spread, by retirement.

The Social Security system can be remodeled with a two-part benefit. The first part, G , is a guaranteed floor that is paid to everyone, irrespective of their earnings or contribution record. The second part, V_i , is individual-specific component and depends on the present value of earnings (or contributions) over the working life. Then:

$$(36) \quad S_i = G + V_i = G + \tilde{\alpha} \sum_{j=1}^{R-1} y_{ij}^b (1+r)^{R-j} = G + \alpha \sum_{j=1}^{R-1} y_{ij} (1+r)^{R-j}$$

where S_i is the annual payment to individual i after retirement. The size of the parameter α determines the extent of the link between earnings in work and the Social Security payments in retirement. When different Social Security systems are examined with respect to their effect on inequality, variations in α and G are considered while holding τ constant. This is equivalent to comparing different allocations of Social Security tax revenues into individual accounts. When α is high relative to G , a system with personal saving accounts, there is relatively little risk-sharing between individuals and higher inequality is expected. When G is large and α is small, the current system in the U.S., risk-sharing is more important and inequality is expected to be lower.

The present value of government revenues from the Social Security taxes levied on the cohort about to retire is:

$$(37) \quad \tau \sum_{j=1}^{R-1} \sum_{i=1}^N y_{ij}^b (1+r)^{R-j} = \tau \sum_{j=1}^{R-1} Y_t (1+r)^{R-j}$$

where N is the total number of people and Y_t is aggregate before-tax earnings for the cohort in year t . The present value of Social Security payments must equal:

$$(38) \quad \sum_{i=1}^N \sum_{j=R}^T (1+r)^{R-j} \left[G + \tilde{\alpha} \sum_{j=1}^{R-1} y_{ij}^b (1+r)^{R-j} \right]$$

The budget constraint that revenues equal outlays shows the relationship between parameters:

$$(39) \quad G + \tilde{\alpha} \bar{y}^* = \frac{\bar{y}^*}{\sum_{j=R}^T (1+r)^{R-j}}$$

The present value of lifetime earnings averaged over all consumers is:

$$(40) \quad \bar{y}^* = \frac{1}{N} \sum_{j=1}^{R-1} Y_j (1+r)^{R-j}$$

where increases in α are equivalent to increases in τ given a within-cohort balanced budget.

Now the system can be reparameterized. The relationship between α and φ , from the present value of each annuity equal to present value of contributions, can be shown as:

$$(41) \quad \varphi = \frac{\tilde{\alpha}}{\tau} \sum_{j=R}^T (1+r)^{R-j}$$

where φ is the fraction of the tax used to build a personal account, the value of which is used to buy an annuity at retirement. Equating the present value of each annuity, V_i , to the present value of contributions gives the relationship between α and φ . So, any increase in the earnings related component of Social Security through an increase in α can be thought of as an increase in the fraction of Social Security taxes that is sequestered into personal accounts. The original budget constraint can be rewritten in terms of φ :

$$(42) \quad G = \frac{\bar{y}^* \tau (1-\varphi)}{\sum_{j=R}^T (1+r)^{j-R}}$$

and the individual social security payment can now be rewritten as:

$$(43) \quad S_i = \frac{\tau}{\sum_{j=R}^T (1+r)^{R-j}} \left[(1-\varphi)\bar{y}^* + \varphi \sum_{j=1}^{R-1} y_{ij}^b (1+r)^{R-j} \right]$$

If the Social Security tax rate is τ , and a fraction φ is invested in a personal account, it is as if the tax rate were reduced to $\tau(1-\varphi)$ and the rate of increase in the consumption, income, and asset variance will be higher. The variance in assets would then change to:

$$(44) \quad \text{var}_t(A) = \text{var}_0(A) + t\sigma_z^2 [1 - \tau(1-\varphi)]^2$$

where an increase in φ , the amount invested in a personal account, would increase the rate in the variance by lowering the risk-sharing component. If this system were established for permanent income consumers who are allowed to lend and borrow, the component of Social Security taxes that does go into personal accounts would have no effect on individual consumption nor its

distribution across individuals. Although the scheme forces people to save, it is fair in present value terms, so it has no effect on the present value of each individuals lifetime resources. And although taxes are paid now and benefits received later, such a transfer can be undone by appropriate borrowing and lending. Of course, none of these results hold if consumers are not allowed to borrow, or if preferences are other than quadratic (Deaton, Gourinchas, and Paxson 2002).

Empirical Strategy

The theoretical framework displayed the example of partially privatized Social Security to show that undoing the risk-sharing nature of the program will further increase the variance in assets. I argue that, in this context of risk-sharing among individuals, the proposed change in Social Security (of introducing personal accounts) and the evolution of private pensions (toward defined-contribution plans) are theoretically identical. Both systems provide a mechanism for risk-sharing that is being undone, which in turn leads to the outcome of more variance in assets among a given cohort of individuals. However, private pensions have in fact undergone this change, while Social Security has not. Thus, the evolution of private pensions provides the data to empirically test the effects of risk-sharing on individuals.

The main hypothesis to test is whether the theoretical relationship between the variance in assets on risk-sharing, as shown in equation (44), is truly negative and significant. The magnitude of this effect and the differences of the effect across asset classes are equally as important. The variance in assets can be modeled as a function of risk-sharing between individuals within a given industry, where the variance in assets is regressed onto two different risk-sharing components in separate equations:

$$(45) \quad \text{Var}[\log(\text{Assets})]_{it} = \alpha + \beta_1 \text{ShareDB}_{it} + \varphi_t + \varepsilon_{it}$$

$$(46) \quad \text{Var}[\log(\text{Assets})]_{it} = \alpha + \gamma_1 \text{ShareDC}_{it} + \varphi_t + \varepsilon_{it}$$

where industry-year observations are used as the exogenous variation and the i subscript now refers to industry. A log linear form of each of these equations is also run, in order to obtain the elasticities associated with these relationships. The coefficient on *ShareDB* is hypothesized to be negative, as this is a case of increasing risk-sharing which should decrease the variance in assets within a cohort. The coefficient on *ShareDC* is hypothesized to be positive, as in this case risk-sharing is decreasing and the variance in assets among a cohort of individuals should grow. A vector of year dummies, φ_t , is included to control for occurrences outside of the risk-sharing process such as market variance. Each functional form specification is run with and without these year dummies.

Data

The main source of data used to test this theoretical model of risk-sharing remains the Health and Retirement Study, which was used to address the concerns of the variance in assets on age.¹³ Once again, a cleaned subset of the original HRS core data is used called the RAND HRS data.¹⁴ The data sample used in this portion of the study differs from part one, as it combines the seven longitudinal waves of the Health and Retirement Study core data from 1992 to 2004 with the unmasked industry codes from the restricted data.¹⁵ The unmasked industry codes are used for the purpose of exogenous variation in the empirical analysis. In addition, using the most specific 3-digit-level SIC industry codes allows for a greater number of industry-

¹³ Health and Retirement Study, public use dataset, 1992-2002. Produced and distributed by the University of Michigan with funding from the National Institute on Aging (grant number NIA U01AG009740). Ann Arbor, MI.

¹⁴ RAND HRS Data, Version F, May 2006. Produced by the RAND Center for the Study of Aging, with funding from the National Institute on Aging and the Social Security Administration. Santa Monica, CA.

¹⁵ HRS Restricted Data, Industry/Occupation, Version 5.0, April 2006.

year observations for the analysis, as the number of unmasked industries in the restricted data far exceeds the number of masked industries in the public data.

The definitions of total assets, financial assets, non-financial assets, and retirement assets remain the same as defined in the first part of the study. Private pension type definitions must now be defined. In the RAND data definitions, there is information on up to three current pension types for each respondent for the years 1992 to 1998. There is information available on up to four current pension types as of 2000. For this study, only the primary current pension type is used.¹⁶ Pension types are defined as either defined-benefit, defined-contribution, or a combination plan, which is both part defined-benefit and part defined-contribution in nature. All of the information collected on private pension types is self-reported. That is, there is the possibility that some individuals misclassify their pension plan into the wrong type, which may cause measurement error in risk-sharing by pension type.^{17,18}

The variance in assets and the composition of private pension types are now calculated by both the masked industry codes from the HRS public data and by the unmasked industry codes in the restricted access data for 1992 to 2004. Under the masked industries, there are only thirteen industry classifications available per year, which total seventy-eight possible masked industry year observations. However, after using the arbitrary cutoff method of at least thirty-five individual observations per masked industry-year, there are seventy-six of these observations left for the analysis. The maximum number of individuals per masked industry-year observation is 1,327, with the average number of 273 individuals per calculation. The variance in assets are then recalculated using the unmasked industries from the restricted data. There are 3,694

¹⁶ In later editions, more information about multiple pension holders may be used.

¹⁷ See Chan and Stephens (2003, 2004) for issues related to self-reported versus employer-provided pension data.

¹⁸ In a future version of this study, this problem will be remedied by using a secondary source of data from the Center for Retirement Research at Boston College, which calculates the composition of private pension types by industry based on the Form 5500 data from the Internal Revenue Service.

unmasked industry year calculations available for analysis after using an arbitrary cutoff point of at least ten individual observations per unmasked industry-year observation. On average, fifty individuals make up each unmasked industry-year calculation, with a maximum number of 2,192 individuals per calculation.

Evidence

The individuals within the Health and Retirement Study display similar compositional trends in private pension types to those of comparable data sources (Figure 3A). The primary pension type of individuals are becoming increasingly defined contribution plans over time, while defined-benefits plans have substantially declined over the same period. Although the data used here begin in 1992, these private pension trends can be traced back at least a decade further within the United States. Within this sample, over sixty percent of individuals begin with a defined-benefit plan type as their primary pension in 1992, with less than thirty-five percent holding a defined-contribution primary pension plan in the same year.¹⁹ The percentage of defined-benefit primary plans decreased to just under forty percent of individuals in 2004, a decline of roughly one third. Also, during this period, defined contribution primary plans climbed to over fifty percent of individual holdings in 2004, an increase of over one third. Both trends seem to decelerate with time over the twelve-year span.

These trends in the composition of private pension types differ when disaggregated by the industries of the current jobs of individuals (Figure 3B). Each of the masked industries included within the public data are shown with the exception of the agriculture, forestry, and fishing industry (coded 1), which did not include enough observations. The decline in defined-

¹⁹ The total percentage numbers of defined-benefit and defined-contribution plans do not add up to 100 percent in any given year due to the existence of combination type plans.

benefit plans and rise in defined-contribution plans are most pronounced in the manufacturing industries of non-durables and durables (3 and 4), the transportation industry (5), the finance, insurance, and real estate industry (8), the business and repair services industry (9), and the professional and related services industry (12). Those industries with flatter or less pronounced trends in private pension composition include the mining and construction industry (2), the wholesale and retail industries (6 and 7), the personal services industry (10), the entertainment and recreation industry (11), and the public administration industry (13). This industry variation in the composition of private pension types is exploited to test the relationship of the variance in assets on risk-sharing. The variance in assets on the percentage of individuals with defined-benefit is analyzed separately from the variance in assets on the percentage of those with defined-contribution plans.

The variance in assets declines as the percentage of primary defined-benefit plan holders increases, while this variance increases as the percentage of defined-contribution holders increases (Figure 4). The linear fit of both risk-sharing relationships still hold even when the few outliers in each figure are thrown out. The confidence intervals are wide around the linear fit of the relationships due to the lower number of masked industries, totaling seventy-six in the sample. However, the linear relationships still hold their sign within these intervals. Due to the relatively small sample size of the masked industries, the industry variation is taken a step further by calculating the variance in assets and the composition of private pension types by unmasked industries. Both linear relationships also hold for unmasked industries as well, negative for defined-benefit and positive for defined-contribution, and the confidence intervals are much more tighter with the inclusion of more observations (Figure 5). Both relationships also hold

across all assets classes: total assets, financial assets, non-financial assets, and retirement assets. This linear trend looks the most pronounced for financial assets.

There is a statistically significant negative relationship of variance in assets on the percentage of defined-benefit holders that holds across all asset classes (Table 2). This shows that as private pension types that share risk across individuals are in decline, the variance in assets between these individual increases. This supports the hypothesis being tested in support of the theoretical framework. A one percent increase in the percentage that hold defined-benefit plans in a given industry decrease the variance in assets by 0.7 percent. A positive significant linear relationship holds across all asset classes for the variance in assets on the percentage of defined-contribution holders (Table 3), showing that increased individual risk does increase the variance in assets of a given cohort. As the percentage of defined-contribution holders in a given industry increased by one percent, the variance in assets grows by 0.8 percent.

The nominal magnitude of the coefficients on variance in financial assets on percentage of defined-benefit holders and defined-contribution holders is the largest of the asset classes. The coefficient on the variance in total assets has the highest percentage decrease for both pension types. The inclusion of time dummies reduces the magnitude of the negative effect across all asset classes for each pension type as well. The negative relationship for defined-benefit plans and the positive relationship for defined-contribution plans provides evidence for the hypothesis that undoing risk-sharing among individuals does increase the cross-sectional variance in assets among them.

Conclusions

The preliminary empirical evidence offered in both sections of this study provide support for the theory that the variance in assets grows as a cohort of individuals age and for the theory that lowering the risk-sharing between individuals also leads to the growth in the variance in assets. The relationship of the variance in assets on age is shown to hold positive and significant across each functional form specification for all asset classes except retirement assets. There is a statistically significant negative relationship of variance in assets on the percentage of defined-benefit holders that holds across all asset classes, while a positive significant relationship holds for the variance in assets on the percentage of defined-contribution holders across all asset classes. The negative relationship for defined-benefit plans and the positive relationship for defined-contribution plans provides evidence for the hypothesis that undoing risk-sharing among individuals does increase the cross-sectional variance in assets among them.

In addition, the variance in assets seems to rise smoothly between the ages of forty and the lower sixties, which then plateaus during retirement years and sharply increases after the age of eighty. The variance in total assets grows at 1.3 percent per each year of age, while the variance in financial and non-financial assets grow at less than 1 percent per each year of age. The variance in retirement assets linearly decreases with age, declining at a rate of 4.2 percent per each year of age. A one percent increase in the percentage that hold defined-benefit plans in a given industry decrease the variance in assets by 0.7 percent. As the percentage of defined-contribution holders in a given industry increased by one percent, the variance in assets grows by 0.8 percent.

The evidence highlights the importance of the age structure on the dynamics of the relative well-being of individuals, as seen through the variance in assets, with policy implications

abound. This offers insight into the relative well-being of individuals and the dynamics of this well-being over the life-cycle. The evidence also identifies one unique consequence of the changing retirement landscape in the United States, and other developed countries, through the evolution of private pensions. This outcome stresses the importance of the traditional role of Social Security and similar schemes that share risk across individuals.

References

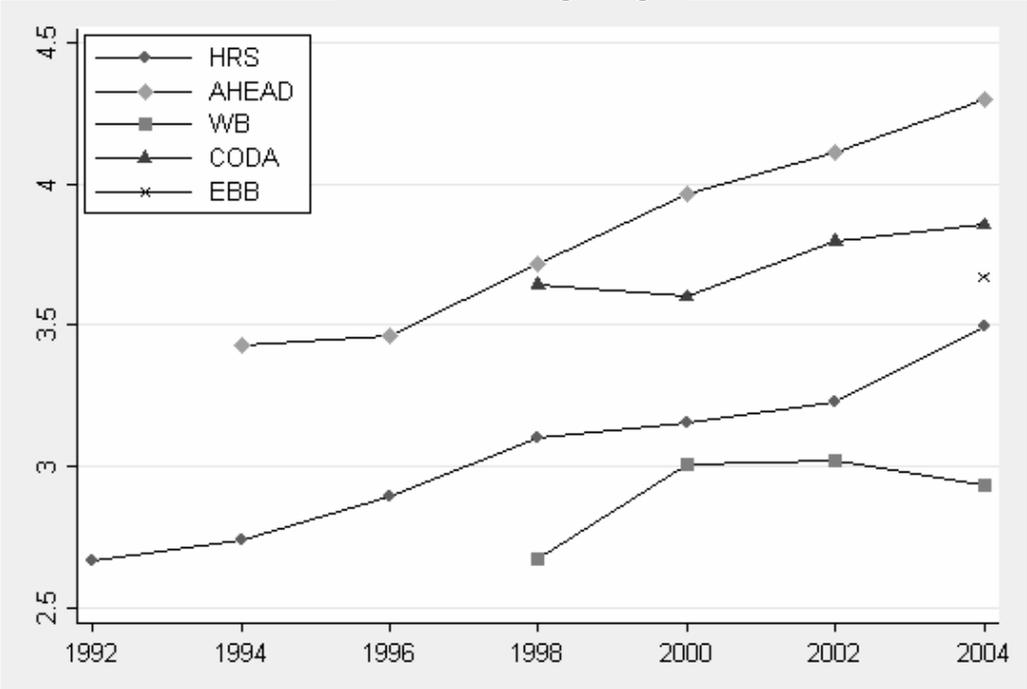
- Aaronson, Stephanie and Coronado, Julia. 2005. "Are Firms or Workers Behind the Shift Away from DB Pension Plans?" Federal Reserve Board, Finance and Economics Discussion Series Working Paper 2005-17, Feb.
- Anderson, Kate, French, Eric, and Lam, Tina. 2004. "You Can't Take It With You: Asset Run-Down at the End of the Life Cycle." *Economic Perspectives*, Federal Reserve Bank of Chicago, 3Q, pp. 40-54.
- Bernheim, B. Douglas, Skinner, Jonathan, and Weinberg, Steven. 2001. "What Accounts for the Variation in Retirement Wealth Among U.S. Households?" *American Economic Review*, Vol. 91, No. 4, Sep., pp. 832-857.
- Blank, Emily C. 1999. "Pension Type and Retirement Wealth." *Industrial Relations*, Vol. 38, No. 1, Jan., pp. 1-10.
- Campbell, John Y. 1987. "Does Saving Anticipate Declining Labor Income? An Alternative Test of the Permanent Income Hypothesis." *Econometrica*, Vol. 55, No. 6, Nov., pp. 1249-1273.
- Chan, Sewin and Stevens, Ann Huff. 2003. "What You Don't Know Can't Help You: Knowledge and Retirement Decision-Making." Working Paper, Dec.
- _____. 2004. "Do Changes in Pension Incentives Affect Retirement? A Longitudinal Study of Subjective Retirement Expectations." *Journal of Public Economics*, Vol. 88, July, pp. 1307-1333.
- Copeland, Craig. 2000. "Pension Coverage: Examining CPS Data." EBRI Notes, Sep., pp. 4-9.
- Deaton, Angus. 1991. "Savings and Liquidity Constraints." *Econometrica*, Vol. 59, No. 5, Sep., pp. 1221-1248.
- _____. 1992. *Understanding Consumption*. Oxford, Clarendon Press. 242 pp.
- Deaton, Angus and Paxson, Christina. 1994. "Intertemporal Choice and Inequality." *Journal of Political Economy*, Vol. 102, No. 3, pp. 437-467.
- _____. 1998. "Health, Income, and Inequality over the Life Cycle." In David Wise, ed., *Frontiers in the Economics of Aging*, University of Chicago Press for NBER, pp. 431-462.
- Deaton, Angus, Gourinchas, Pierre-Olivier, and Paxson, Christina. 2002. "Social Security and Inequality over the Life Cycle." In Martin Feldstein and Jeff Leibman, eds., *The Distributional Effects of Social Security Reform*, Chicago University Press for NBER, pp. 115-148.

- Engelhardt, Gary. 2004. "Defined Contribution Pension Plans and the Measurement of Retirement Wealth: Implications for Studies of Pension Knowledge, Saving, and the Timing of Retirement." Report submitted to TIAA-CREF, Dec.
- Flavin, Marjorie A. 1981. "The Adjustment of Consumption to Changing Expectations About Future Income." *Journal of Political Economy*, Vol. 89, No. 5, Oct., pp. 974-1009.
- Friedberg, Leora and Owyang, Michael. 2002. "Not Your Father's Pension Plan: The Rise of 401(k) and Other Defined Contribution Plans." *Federal Reserve Bank of St. Louis Review*, Vol. 84, No. 1, pp. 23-34.
- _____. 2004. "Explaining the Evolution of Pension Structure and Job Tenure." NBER Working Paper No. 10714, 50 pp.
- Friedberg, Leora and Webb, Anthony. 2005. "Retirement and the Evolution of Pension Structure." *Journal of Human Resources*, Vol. 40, No. 2, pp. 281-308.
- Friedman, Milton. 1957. *A Theory of the Consumption Function*. Princeton, Princeton University Press, 259 pp.
- Gustman, Alan L., Mitchell, Olivia S., Samwick, Andrew A., and Steinmeier, Thomas L. 1999. "Pension and Social Security Wealth in the Health and Retirement Study." In James Smith and Robert Willis, eds., *Wealth, Work, and Health: Innovations in Measurement in the Social Sciences*, Ann Arbor, University of Michigan Press, pp. 150-208.
- Lusardi, Annamarie, Skinner, Jonathan, and Venti, Steven. 2002. "Saving, Public Policy, and Late-Life Inequality." *Annual Review of Gerontology and Geriatrics*, Vol. 22, Springer Publishing Co.
- Markowitz, Harry W. 1952. "Portfolio Selection." *Journal of Finance*, Vol. 7, No. 1, pp. 77-91.
- _____. 1959. *Portfolio Selection: Efficient Diversification of Investments*. Blackwell, 384 pp.
- McGarry, Kathleen and Davenport, Andrew. 1998. "Pensions and the Distribution of Wealth." In David Wise, ed., *Frontiers in the Economics of Aging*, University of Chicago Press for NBER, pp. 463-485.
- Mitchell, Olivia S. and Smetters, Kent. 2003. "Overview: Developments in Risk Management for Retirement Security." In Olivia S. Mitchell and Kent Smetters, eds., *The Pension Challenge: Risk Transfers and Retirement Income Security*, Oxford University Press, pp. 1-15.

- Modigliani, Franco and Brumberg, Richard. 1954. "Utility Analysis and the Consumption Function: An Interpretation of Cross-Section Data." In Kenneth K. Kurihara, ed., *Post-Keynesian Economics*, New Brunswick, NJ, Rutgers University Press, pp. 388-436.
- Murphy, Kevin M. and Finis Welch. 1990. "Empirical Age-Earnings Profiles." *Journal of Labor Economics*. Vol. 8, No. 2, Apr., pp. 202-229.
- Poterba, James M. 2004. "Valuing Assets in Retirement Savings Accounts." Center for Retirement Research Working Paper 2004-11, April.
- Shiller, Robert. 2003. "Social Security and Individual Accounts as Elements of Overall Risk-Sharing." *American Economic Review Papers and Proceedings*, Vol. 93, No. 2, pp. 343-347.
- Storesletten, Kjetil, Telmer, Chris, and Yaron, Amir. 2004. "Consumption and Risk Sharing Over the Life Cycle." *Journal of Monetary Economics*, Vol. 51, No. 3, Apr., pp. 609-633.
- Venti, Steven F. and Wise, David A. 1998. "The Cause of Wealth Dispersion at Retirement: Choice or Chance?" *American Economic Review Papers and Proceedings*, Vol. 88, No. 2, pp. 185-191.
- _____. 2001. "Choice, Chance, and Wealth Dispersion at Retirement." In S. Ogura, T. Tachibanaki, and D. Wise, eds., *Aging Issues in the United States and Japan*, University of Chicago Press.
- Wolff, Edward N. 1981. "The Accumulation of Wealth Over the Life-Cycle: A Microdata Analysis." *Review of Income and Wealth*, Vol. 27, No. 1, March, pp. 75-96.
- _____. 1990. "Methodological Issues in the Estimation of the Size Distribution of Household Wealth." *Journal of Econometrics*, Vol. 43, No. 1/2, Jan/Feb, 179-195.
- _____. 1992. "Changing Inequality of Wealth." *American Economic Review Papers and Proceedings*, Vol. 82, No. 2, May, 552-558.
- _____. 2005. "Is the Equalizing Effect of Retirement Wealth Wearing Off?" Levy Working Paper No. 420.

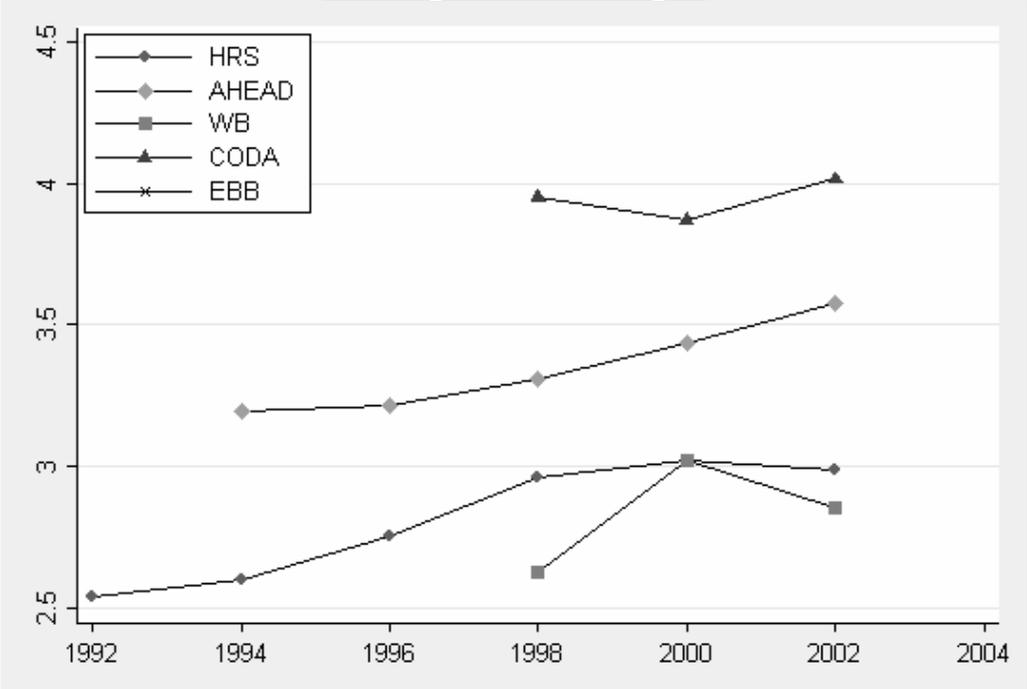
Figure 1. Variance of the Logarithm of Total Assets Over Time By Pre-Specified Age Cohorts

A. Without Using Weights



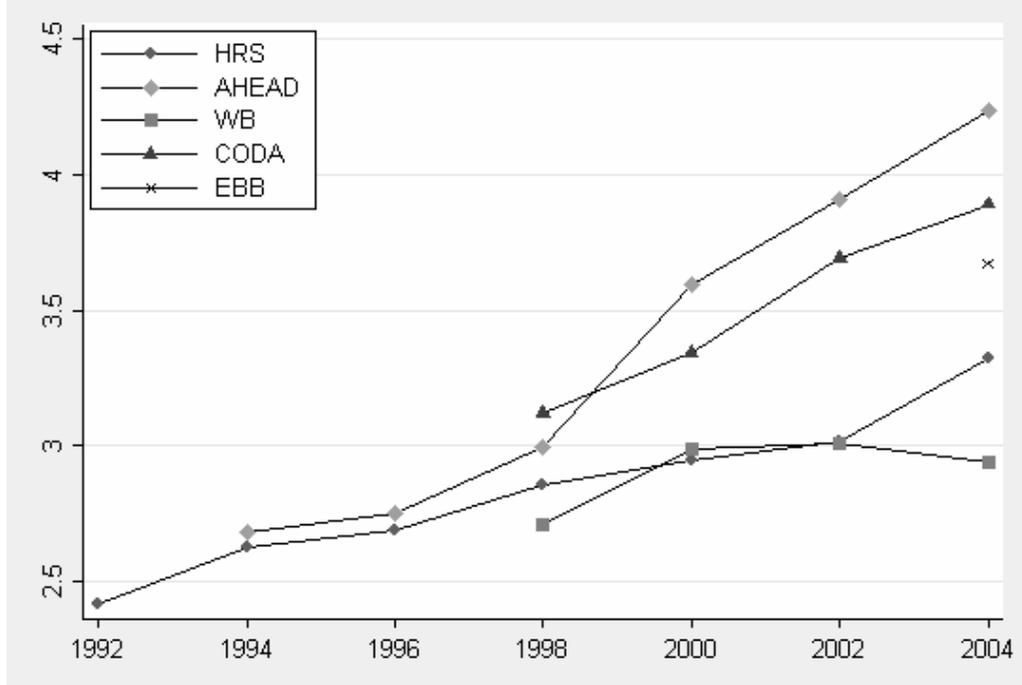
Source: Author’s calculations of Health and Retirement Study data.

B. Using Household Weights



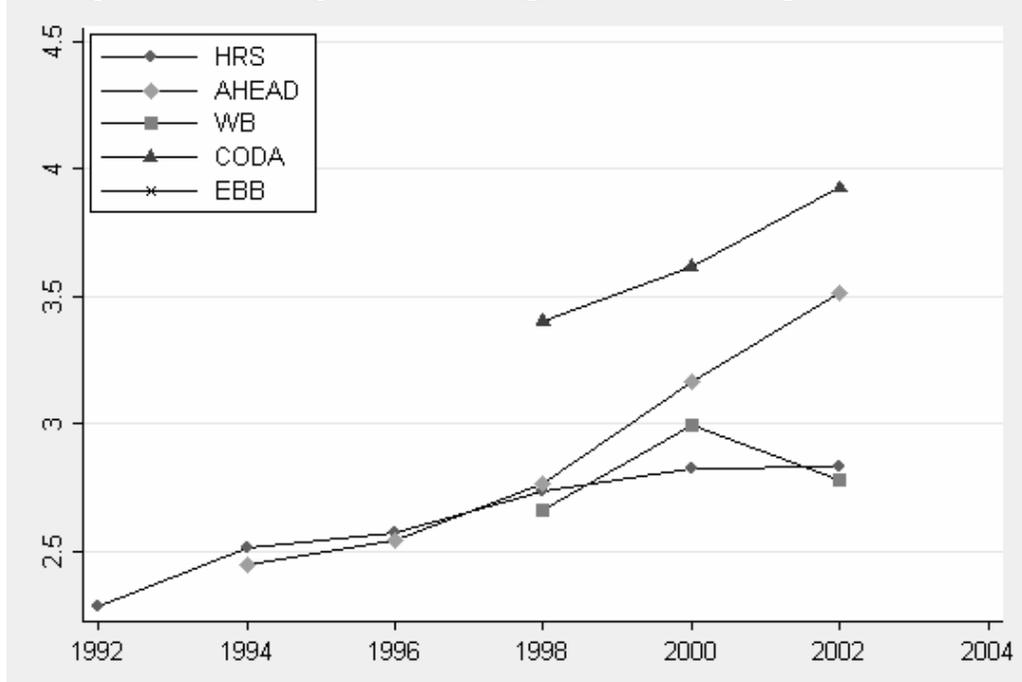
Source: Author’s calculations of Health and Retirement Study data.

C. Without Using Weights and Limiting to Those Who Responded in All Waves



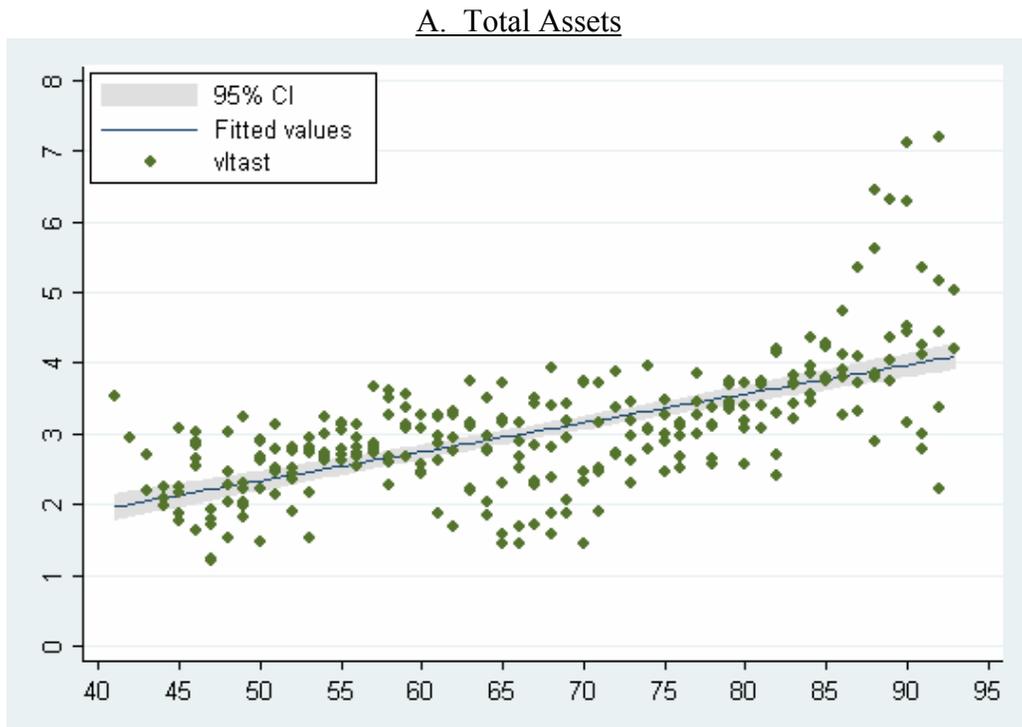
Source: Author's calculations of Health and Retirement Study data.

D. Using Household Weights and Limiting to Those Who Responded in All Waves

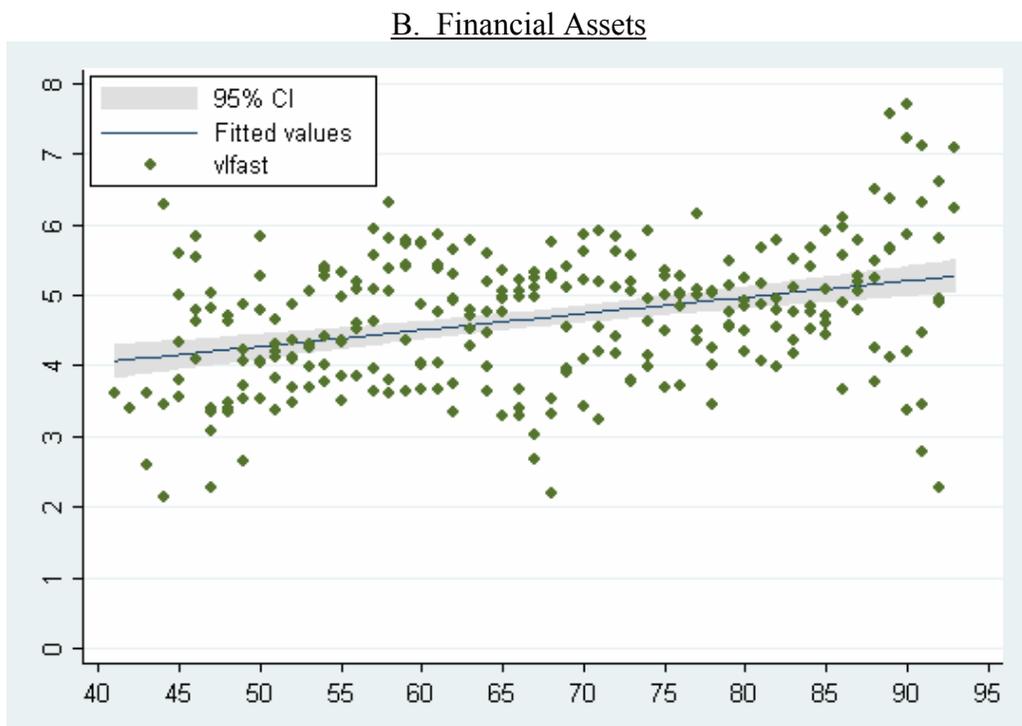


Source: Author's calculations of Health and Retirement Study data.

Figure 2. Variance of the Logarithm of Assets on Age With a Linear Fit, Using Weights

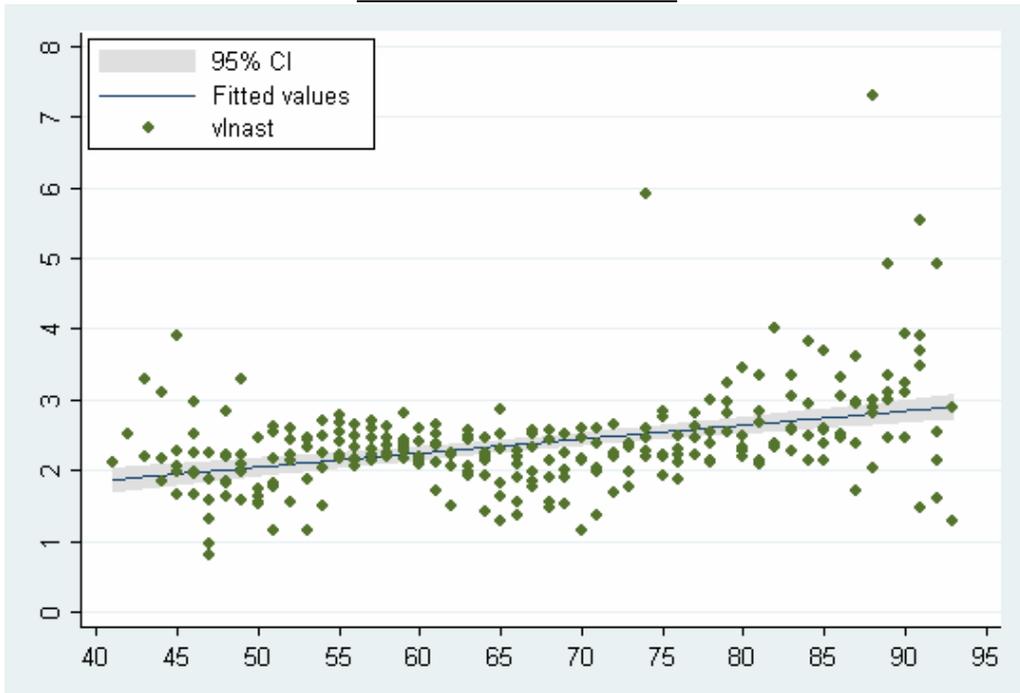


Source: Author's calculations of Health and Retirement Study data.



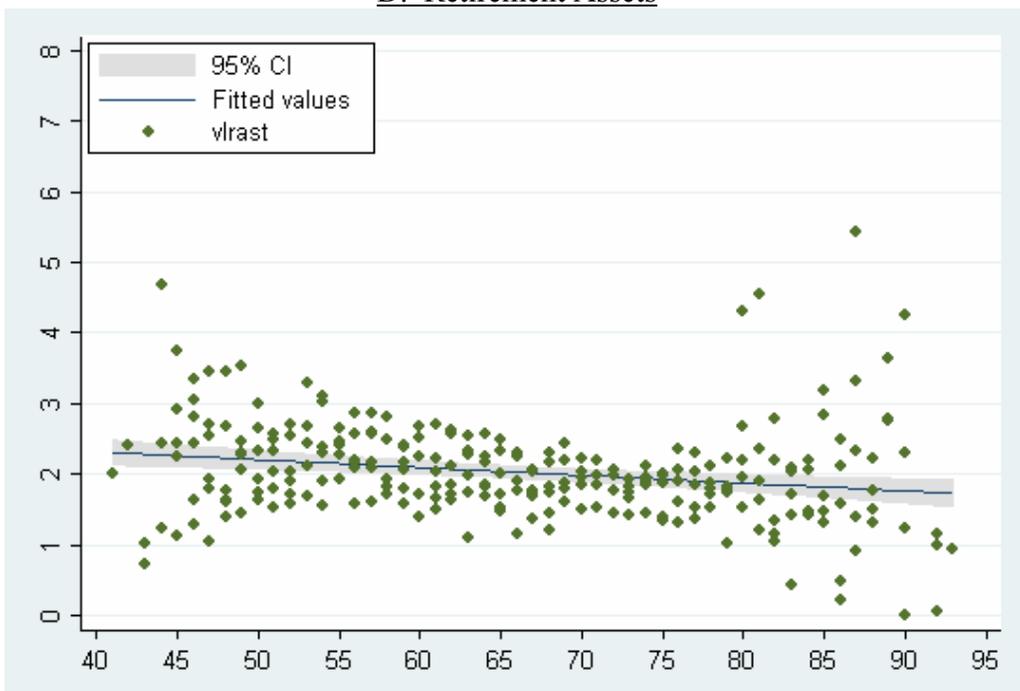
Source: Author's calculations of Health and Retirement Study data.

C. Non-Financial Assets



Source: Author's calculations of Health and Retirement Study data.

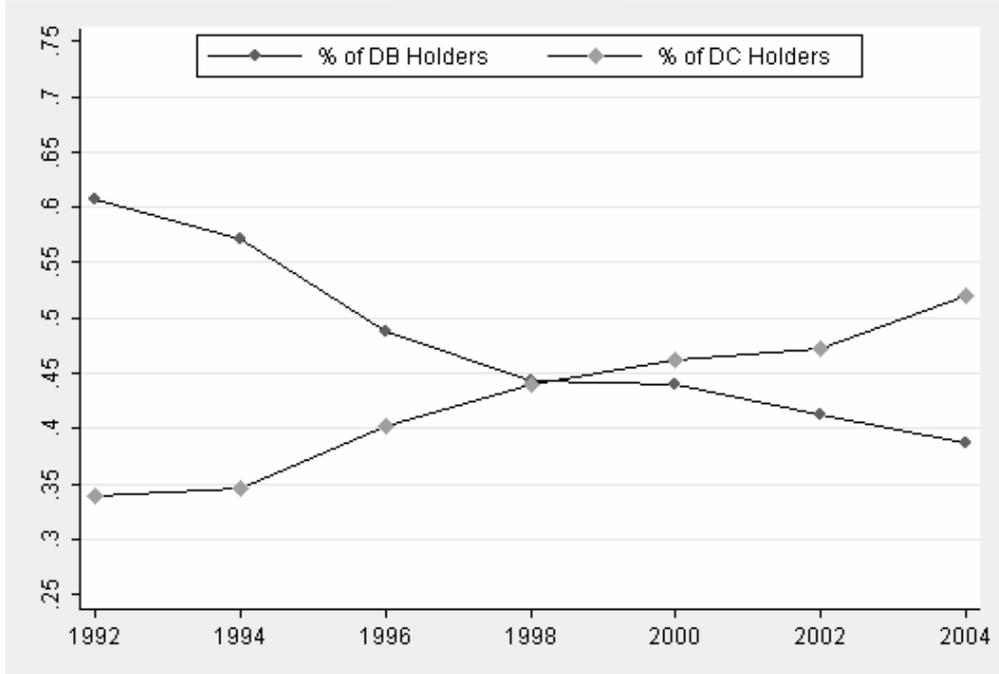
D. Retirement Assets (vlrast)



Source: Author's calculations of Health and Retirement Study data.

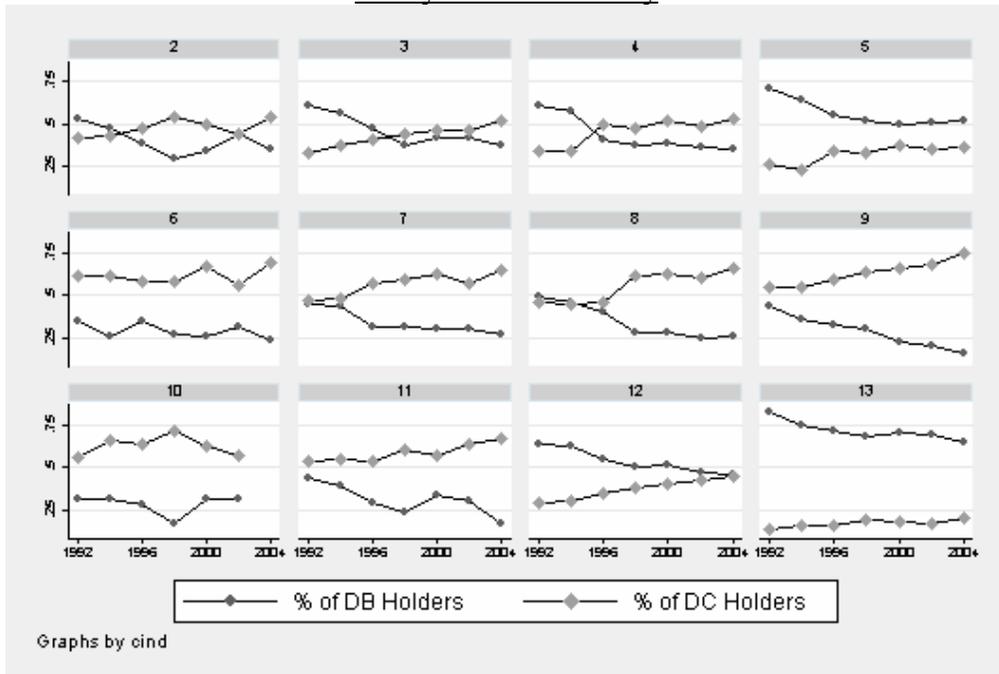
Figure 3. Composition of Primary Pension Types Over Time

A. Overall Trend



Source: Author's calculations of Health and Retirement Study data.

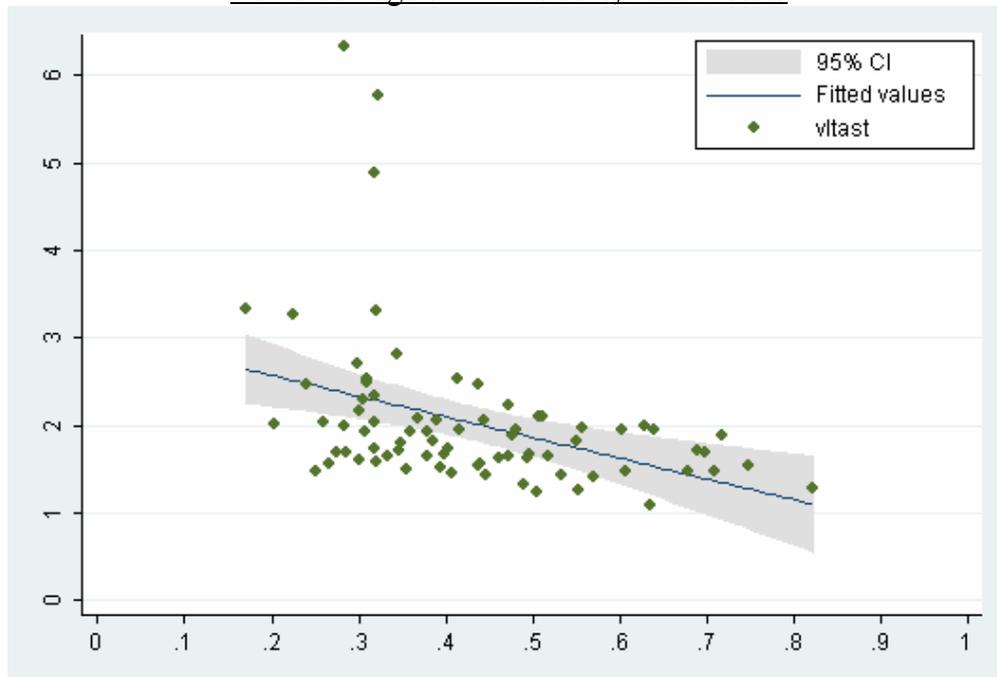
B. By Masked Industry



Source: Author's calculations of Health and Retirement Study data.

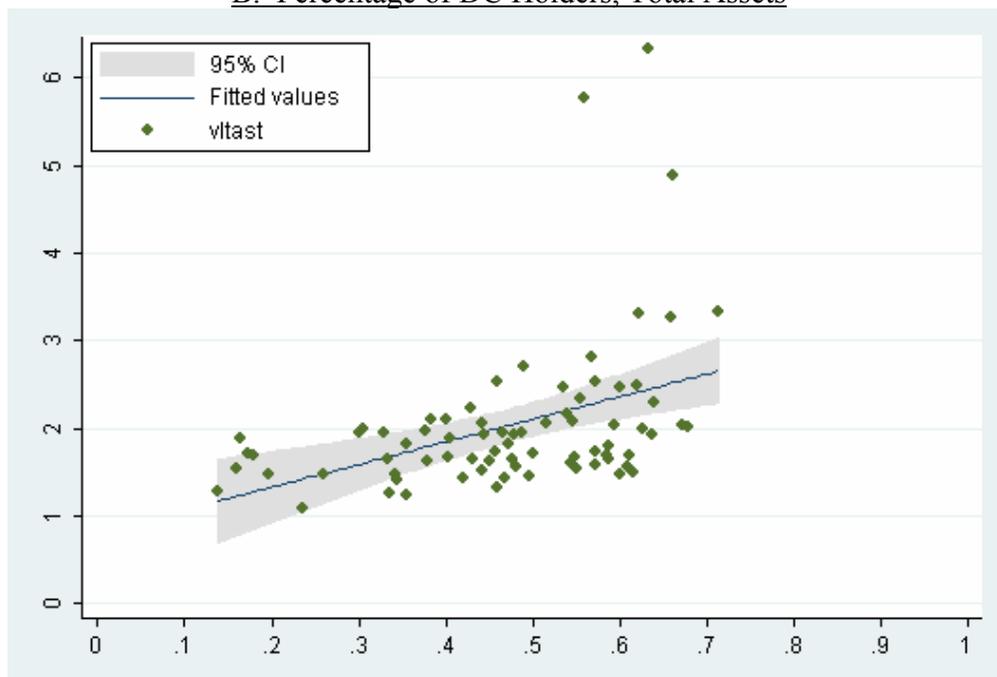
Figure 4. Variance of the Logarithm of Assets on Risk-Sharing Measures With a Linear Fit, By Total Assets Using *Masked* Industry Variation and Using Weights

A. Percentage of DB Holders, Total Assets



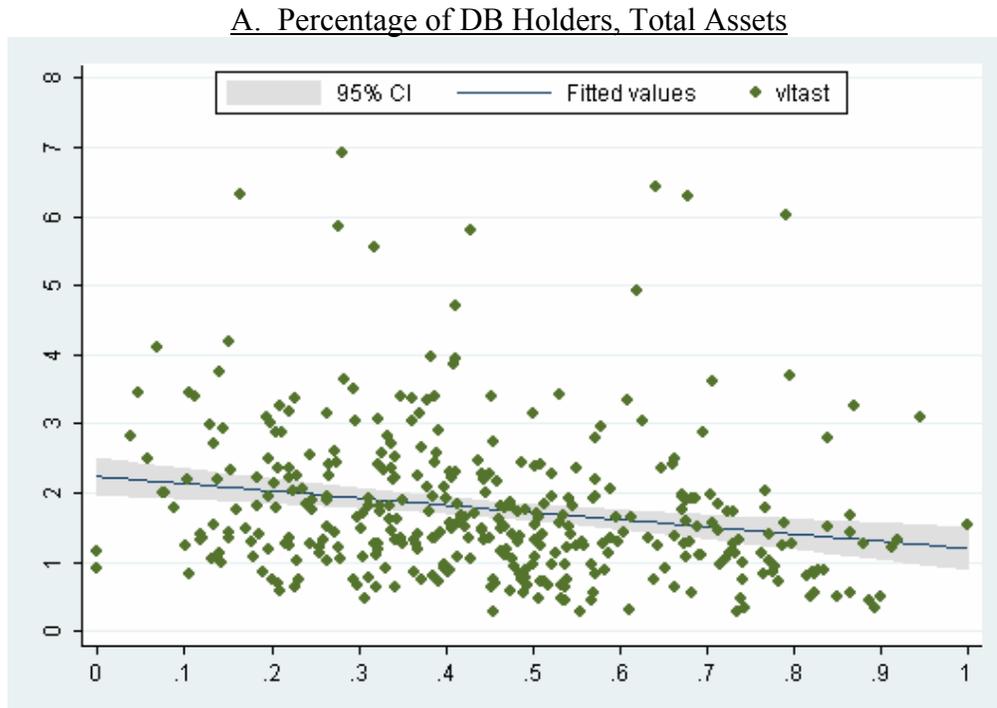
Source: Author's calculations of Health and Retirement Study data.

B. Percentage of DC Holders, Total Assets

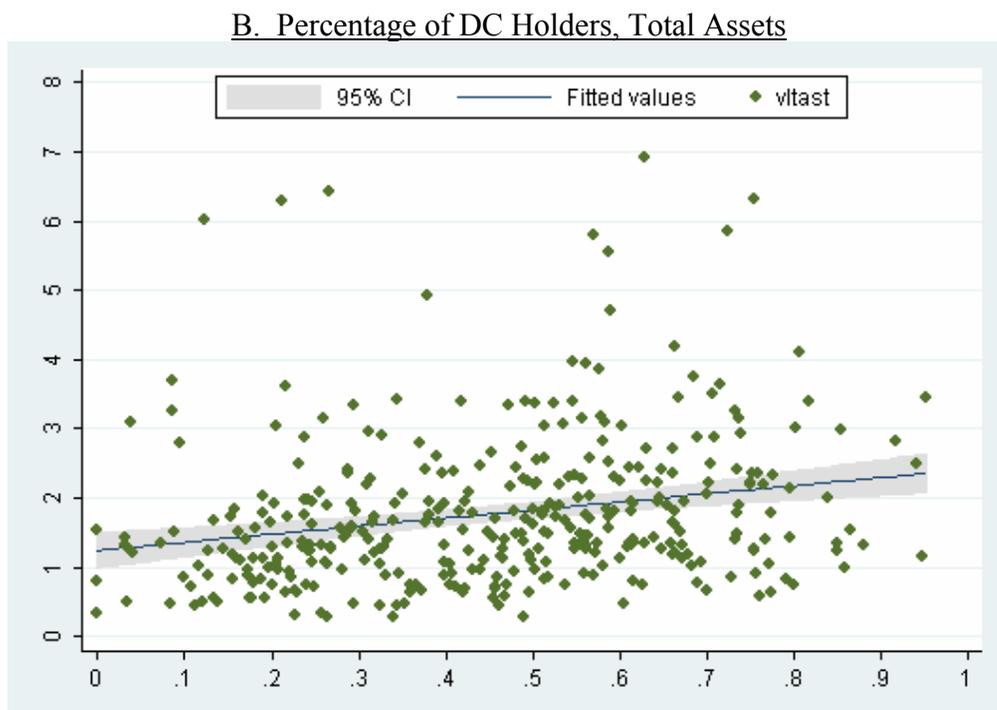


Source: Author's calculations of Health and Retirement Study data.

Figure 5. Variance of the Logarithm of Assets on Risk-Sharing Measures With a Linear Fit, By Asset Classes Using *Unmasked* Industry Variation and Using Weights

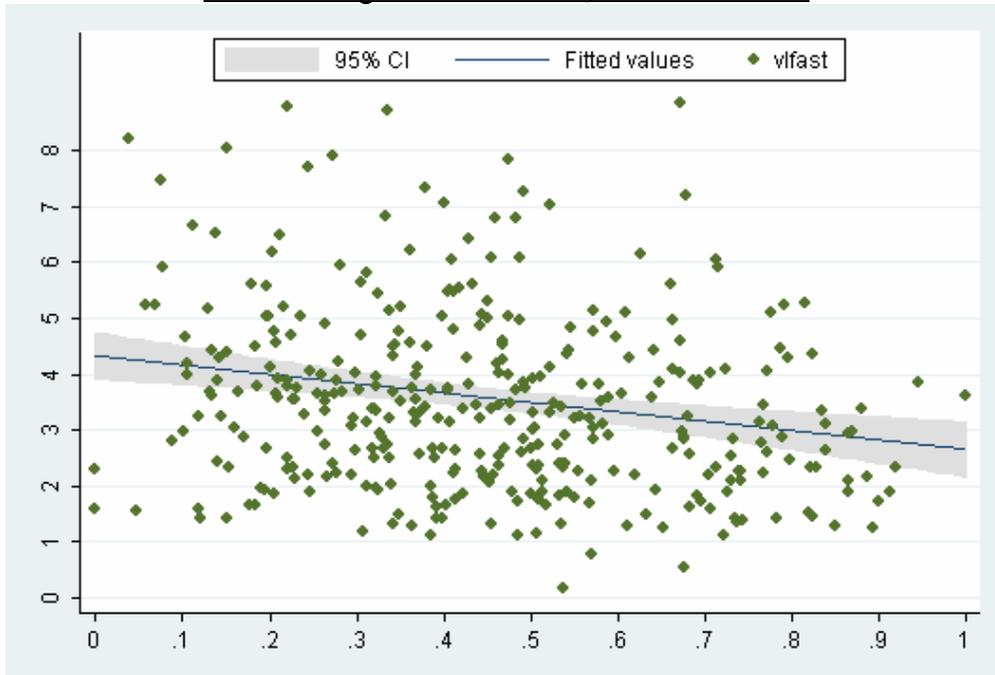


Source: Author's calculations of Health and Retirement Study data.



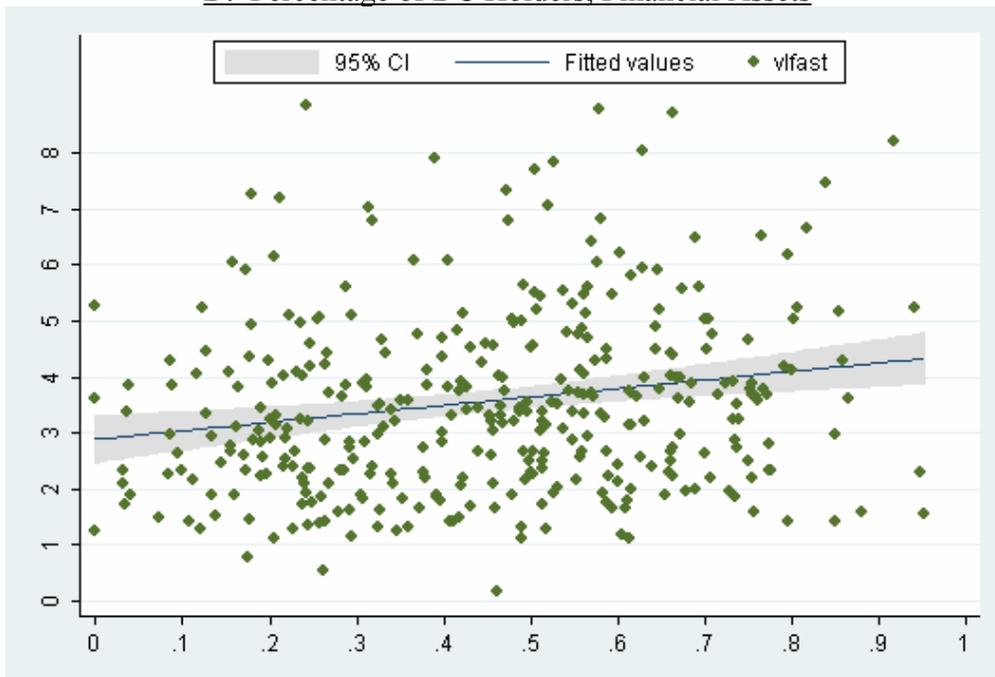
Source: Author's calculations of Health and Retirement Study data.

C. Percentage of DB Holders, Financial Assets



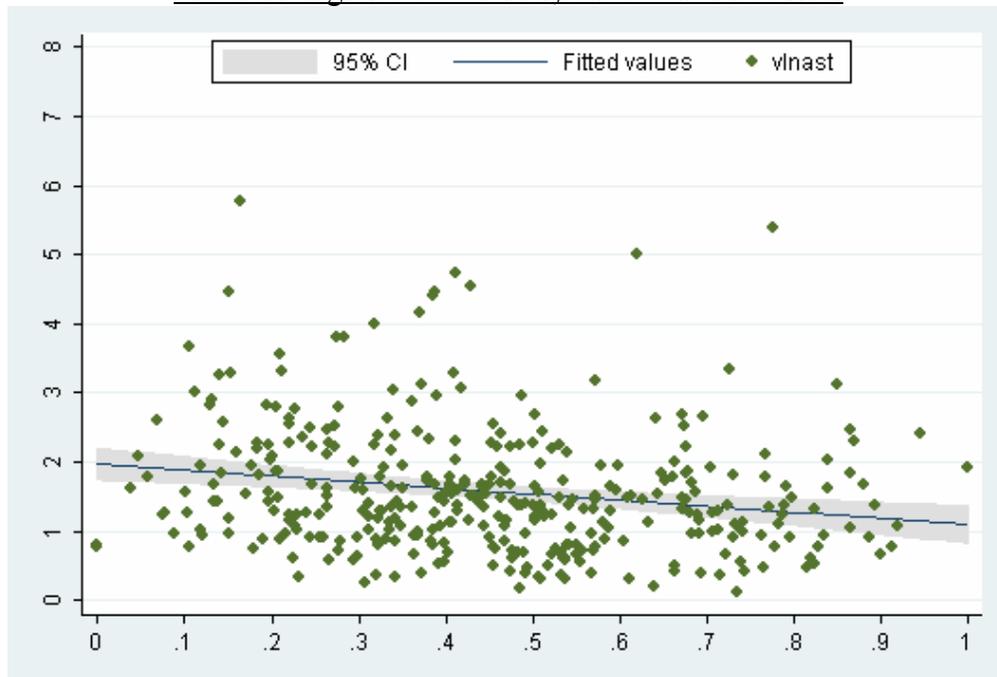
Source: Author's calculations of Health and Retirement Study data.

D. Percentage of DC Holders, Financial Assets



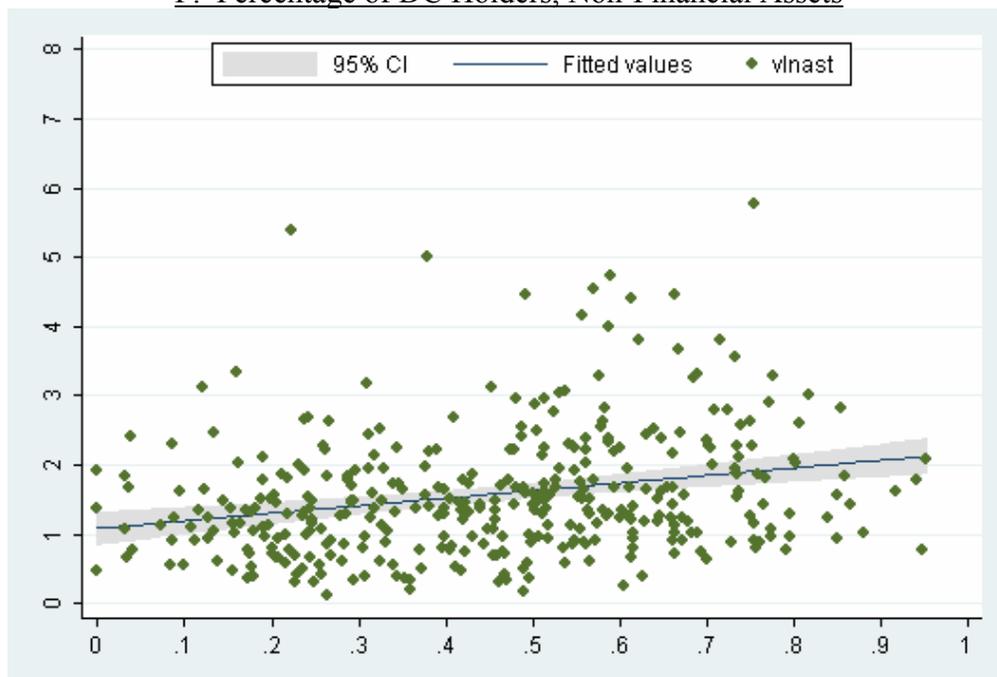
Source: Author's calculations of Health and Retirement Study data.

E. Percentage of DB Holders, Non-Financial Assets



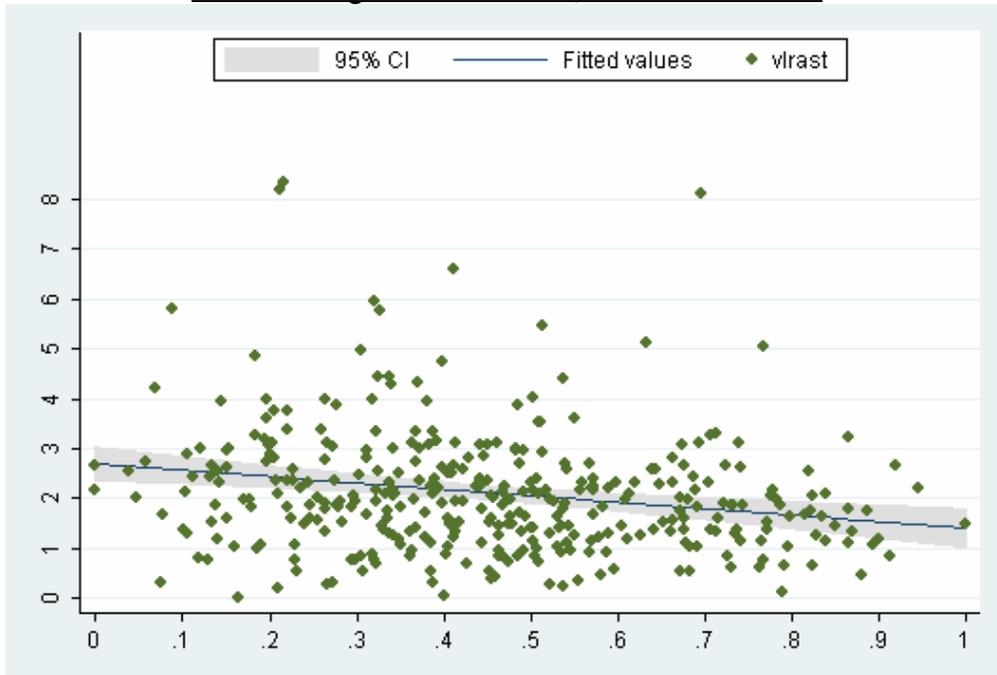
Source: Author's calculations of Health and Retirement Study data.

F. Percentage of DC Holders, Non-Financial Assets



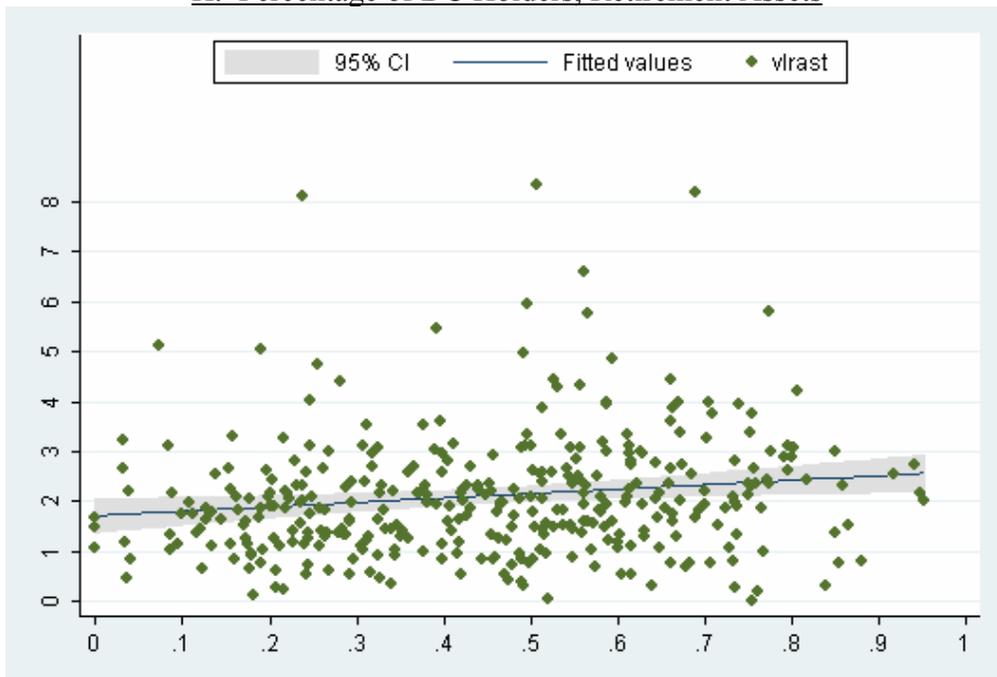
Source: Author's calculations of Health and Retirement Study data.

G. Percentage of DB Holders, Retirement Assets



Source: Author's calculations of Health and Retirement Study data.

H. Percentage of DC Holders, Retirement Assets



Source: Author's calculations of Health and Retirement Study data.

Table 1. Variance of the Logarithm of Assets on Age OLS Regression Results by Asset Classes

Total Assets (n=272)	Linear Fit		Cubic Fit		Elasticity	
	(1)	(2)	(3)	(4)	(5)	(6)
Age	0.041 (0.003) [0.000]	0.039 (0.003) [0.000]	0.556 (0.227) [0.015]	0.514 (0.2223) [0.023]	0.013 (0.001) [0.000]	0.012 (0.001) [0.000]
year dummies		X		X		X
R-squared	0.41	0.44	0.48	0.51	0.39	0.44
Financial						
Assets (n=271)	(1)	(2)	(3)	(4)	(5)	(6)
Age	0.023 (0.004) [0.000]	0.016 (0.003) [0.000]	0.798 (0.303) [0.009]	0.625 (0.238) [0.009]	0.005 (0.001) [0.000]	0.003 (0.001) [0.000]
year dummies		X		X		X
R-squared	0.12	0.47	0.14	0.48	0.11	0.45
Non-Financial						
Assets (n=270)	(1)	(2)	(3)	(4)	(5)	(6)
Age	0.020 (0.003) [0.000]	0.021 (0.003) [0.000]	-0.014 (0.219) [0.951]	0.032 (0.215) [0.881]	0.007 (0.001) [0.000]	0.008 (0.001) [0.000]
year dummies		X		X		X
R-squared	0.16	0.20	0.20	0.26	0.16	0.20
Retirement						
Assets (n=260)	(1)	(2)	(3)	(4)	(5)	(6)
Age	-0.011 (0.003) [0.000]	-0.017 (0.003) [0.000]	0.049 (0.250) [0.846]	-0.119 (0.228) [0.601]	-0.042 (0.019) [0.030]	-0.047 (0.020) [0.021]
year dummies		X		X		X
R-squared	0.05	0.23	0.05	0.23	0.02	0.04

Source: Author's calculations of Health and Retirement Study data.

Notes: Standard errors in parentheses. P-values in brackets. The AIC criterion is minimized for the correct function form on age in equations (3) and (4). All calculations are made using household-level analytical weights.

Table 2. Variance of the Logarithm of Assets on Percentage of DB Holders
 OLS Regression Results by Asset Classes Using *Unmasked* Industries

Total Assets (n=364)	Linear Fit		Elasticity	
	(1)	(2)	(3)	(4)
% of DB Holders	-0.010 (0.003) [0.000]	-0.009 (0.003) [0.001]	-0.007 (0.001) [0.000]	-0.006 (0.002) [0.000]
year dummies		X		X
R-squared	0.04	0.07	0.07	0.10
<hr/>				
Financial Assets (n=364)				
% of DB Holders	-0.016 (0.004) [0.000]	-0.013 (0.005) [0.004]	-0.005 (0.001) [0.000]	-0.004 (0.001) [0.005]
year dummies		X		X
R-squared	0.04	0.06	0.04	0.06
<hr/>				
Non-Financial Assets (n=364)				
% of DB Holders	-0.009 (0.002) [0.000]	-0.009 (0.003) [0.001]	-0.006 (0.001) [0.000]	-0.006 (0.002) [0.000]
year dummies		X		X
R-squared	0.04	0.05	0.04	0.05
<hr/>				
Retirement Assets (n=362)				
% of DB Holders	-0.013 (0.003) [0.000]	-0.011 (0.004) [0.004]	-0.005 (0.001) [0.009]	-0.003 (0.002) [0.074]
year dummies		X		X
R-squared	0.04	0.06	0.02	0.04

Source: Author's calculations of Health and Retirement Study data.

Notes: Standard errors in parentheses. P-values in brackets. All calculations are made using household-level analytical weights.

Table 3. Variance of the Logarithm of Assets on Percentage of DC Holders
 OLS Regression Results by Asset Classes Using *Unmasked* Industries

Total Assets (n=364)	Linear Fit		Elasticity	
	(1)	(2)	(3)	(4)
% of DC Holders	0.011 (0.002) [0.000]	0.010 (0.002) [0.000]	0.008 (0.001) [0.000]	0.007 (0.001) [0.000]
year dummies		X		X
R-squared	0.05	0.08	0.08	0.11
<hr/>				
Financial Assets (n=364)				
% of DC Holders	0.015 (0.004) [0.000]	0.012 (0.004) [0.006]	0.004 (0.001) [0.000]	0.003 (0.001) [0.010]
year dummies		X		X
R-squared	0.03	0.06	0.03	0.06
<hr/>				
Non-Financial Assets (n=364)				
% of DC Holders	0.011 (0.002) [0.000]	0.011 (0.002) [0.000]	0.007 (0.001) [0.000]	0.007 (0.002) [0.000]
year dummies		X		X
R-squared	0.06	0.07	0.06	0.07
<hr/>				
Retirement Assets (n=362)				
% of DC Holders	0.009 (0.003) [0.009]	0.006 (0.003) [0.070]	0.003 (0.002) [0.050]	0.002 (0.002) [0.235]
year dummies		X		X
R-squared	0.02	0.04	0.01	0.04

Source: Author's calculations of Health and Retirement Study data.

Notes: Standard errors in parentheses. P-values in brackets. All calculations are made using household-level analytical weights.