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THE EVOLUTION OF PRIVATE PENSIONS, RISK-SHARING, AND THE VARIANCE IN ASSETS

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ABSTRACT

This study examines the effects of risk-sharing arrangements on the relative economic outcomes of older individuals. I set the observed risk-changing event provided by the evolution of private pensions within a theoretical model for Social Security, in order to better evaluate the effects of risk-sharing on individuals. To empirically measure these effects, I use the composition of private pension types as a proxy for risk-sharing and the variance in assets as a proxy for the relative economic differences across individuals. Two-stage least squares is employed for the analysis with industry indicators serving as the instruments. The data are provided by the Health and Retirement Study, the employer-provided Form 5500s, and the Current Population Survey. The evidence shows that the broad shift in the composition of private pensions has increased the risk exposure of pension-holding individuals, which thereby increases the variance in assets within cohorts. This translates into larger differences in the economic outcomes of individuals as measured by their assets. A ten percent reduction in defined-benefit plans together with a ten percent rise in defined-contribution plans will lead to an asset variance increase between 9.2 and 11.2 percent for pension holders and between 2.2 and 8.6 percent for the whole population. These findings for private pensions have direct implications for issues concerning changes to Social Security and, more generally, for the future of retirement income security within the United States.

Keywords: assets, life-cycle, private pensions, risk-sharing, Social Security, variance

JEL Codes: D31, D91, H55, J26, J32

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INTRODUCTION

Over the past quarter century, employer-provided private pensions have undergone considerable change in the United States. There has been a substantial shift away from defined-benefit pension plans and toward defined-contribution plans.[1] These two pension types vary in the way they share risks: defined-benefit plans share more risk across groups, while defined-contribution plans introduce more individual risk (Barr and Diamond 2006). Therefore, this evolution toward defined-contribution pensions exposes individuals to increased risk by dissolving the risk-sharing aspects of defined-benefit pension arrangements. Questions immediately arise as to how individuals have been affected by such a change.

This is not the only example of diminished risk-sharing among individuals at present. In recent years, there have been proposals to introduce personal retirement accounts into Social Security. Such a change would dilute the very essence of social insurance, where risks are shared even more broadly and across more individuals than in private pensions. Deaton, Gourinchas, and Paxson (2002) develop a theoretical model that uses this example of partially privatized Social Security to show that reducing risk-sharing within cohorts of similar-aged individuals will result in larger differences in their relative economic outcomes. These differences, or inequalities, can be represented by the variance in the collectively accumulated assets of a given cohort.

This study marries the observed risk-changing event provided by the evolution of private pensions with the theoretical framework regarding the introduction of individual accounts to Social Security. I argue that within the context of risk-sharing, introducing personal retirement accounts into Social Security and the shift in private pensions toward defined-contribution plans

[1] Papke (1999) provides evidence that employers are substituting defined-contribution plans for the more traditional defined-benefit plans, and employers that introduce a defined-contribution plan are more likely to terminate their defined-benefit plan.

are theoretically identical. If Social Security is partially privatized, the broad risk-sharing mechanism in both systems will have been dissolved in favor of individual risk, which in turn should lead to larger differences in relative outcomes. Parallels are drawn between these risk-sharing systems to better understand how the evolution of private pensions can be examined with the theoretical model for Social Security. Unlike Social Security, however, private pensions have undergone this risk-sharing change and provide the empirical data necessary to measure these effects of risk-sharing on the relative differences across individuals.

For this measurement, I use the composition of private pension types as a proxy for risk-sharing and the variance in assets as a proxy for the relative differences across individuals. To address any potential bias to the estimates, a two-stage least squares procedure is used, with industry indicators serving as the instrument. In short, the industry changes in private pensions are assumed to be uncorrelated with changes in the variance in earnings and in assets. The data for the analysis are provided by the Health and Retirement Study for assets and the employer-provided Form 5500 data for pensions, with additional information from the Current Population Survey. I find that the private pension shift is associated with increased differences in the relative economic outcomes between individuals through the increased variance in their collective assets.

Most papers in the recent literature that discuss risk-sharing do so in terms of Social Security, by evaluating the potential outcomes of introducing individual accounts.[2] In Nathan (2006), Jeffrey Brown and Kenneth Apfel debate whether individual accounts would be an improvement to Social Security. In terms of the increased risk exposure, Brown argues that this would be a good addition to traditional Social Security, given the higher returns and individuals'

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[2] For a few studies that discuss risk-sharing in the broader terms of retirement income security, see Mitchell and Smetters (2003) and the Pension Research Council (2005).

ability to choose different investment options based on their aversion to risk. Apfel, however, makes the argument that even with better returns, this type of risk exposure is not well suited within the role of basic retirement needs provided by Social Security. Nataraj and Shoven (2003) parameterize the risk and return of both individual accounts and traditional Social Security. They find that the returns of the traditional program are far less volatile than a 60-40 stocks-bonds mix in an individual account. However, they do champion the two-tier program due to the portfolio diversification offered to those who solely rely on Social Security to fund their retirement. Burtless (2003) argues that the magnitude of the risk in the proposed individual accounts is large enough that they would not be tolerated in most industrialized countries. Shiller (2003) outlines the risk-return tradeoffs of individual accounts and states the importance of defining investment choices to protect individuals from their own ignorance or irrationality. He also notes that information on relative risk aversion should be utilized when thinking about Social Security.

Several outcomes of the private pension shift have also been evaluated in the recent literature. Friedberg and Webb (2005) report that workers retire almost two years later on average under defined-contribution plans than they would otherwise under defined-benefit plans. Poterba, Ruah, Venti, and Wise (2007) show that average retirement wealth accruals are larger under defined-contribution plans than under defined-benefit plans, but the heterogeneity in both plan types implies many deviations from this finding. Wolff (2003) finds that the rise in defined-contribution plans more than fully compensates for the decline in defined-benefit plans in terms of average wealth, but increased defined-contribution wealth may be overstated due to its accompanying strong stock market conditions during the period of analysis. Samwick and Skinner (2004) show with simulations that pension wealth upon retirement in defined-contribution plans will dominate that of defined-benefit plans, while Even and Macpherson (2007) conclude that in addition to this rise in the level of pension wealth, the private pension shift will also increase the inequality of pension wealth upon retirement.

The primary purpose of this study is to identify the effects of changes in risk-sharing arrangements upon individuals. In doing so, I identify one unique outcome of the change in private pensions: the private pension shift is shown to increase differences in the relative economic outcomes between individuals through the increased variance in their collective assets. This outcome suggests that introducing individual accounts into Social Security might result in a similar increase in the differences of relative economic outcomes between individuals. Private pensions and Social Security together make up the bulk of retirement income security within the United States, along with private savings.[3] Therefore, if the evolution of private pensions is found to increase relative differences across individuals, then the introduction of individual accounts to Social Security might only further exacerbate these differences through an increased exposure of individual risk if individuals do not adjust their total portfolios accordingly.

The organization of the paper is as follows. First, the evolution of private pensions is discussed in greater detail. Next, the theoretical framework regarding the effects of risk-sharing on assets is introduced. Then, the empirical approach is defended. Fourth, each of the contributing data sets is described. The evidence of the measured effects of risk-sharing on the variance in assets is presented thereafter. A discussion concludes the paper.

[3] Hohaus (1962) may have been the first to apply the metaphor of the three-legged stool to retirement income in the United States, with one leg representing Social Security, one leg representing private pensions, and the last leg representing private savings. Gale, Shoven, and Warshawsky (2005) also make use of this concept.

THE EVOLUTION OF PRIVATE PENSIONS

Different types of private pensions are associated with different levels of risk-sharing (Barr and Diamond 2006). In general, defined-benefit plans share more risk across individuals, while defined-contribution plans introduce more individual risk. Under defined-benefit plans, the *employer* bears all of the interest rate risk, inflation risk, under-funding risk, and lifespan risk, while the *employee* faces the risk of plan termination, an early severance, and the incentive to retire at the employer's pleasure. Under defined-contribution plans, the *employee* bears all of these risks, but there is no longer the risk of an early severance due to the portability of this plan type.[4] While both pension types are associated with different risks, it is recognized that neither is free of risk (Bodie, Marcus, and Merton 1988).

These plans also differ in who controls the assets. In defined-benefit plans, the employer controls how the underlying assets are invested and bears the associated risks. In defined-contribution plans, the employer defines the set of choices, but the employee makes the investment decisions. Therefore, the evolution of private pensions from defined-benefit to defined-contribution plans has pushed much of the control associated with retirement savings onto the individual, along with the added risk.

Some causes of this private pension shift have recently been discussed. Aaronson and Coronado (2005) find that aggregate factors affecting all firms, such as regulatory burden and increased life expectancy, have helped to explain the shift. In addition, it is found that certain workers and firms in today's work environment favor pension plans that do not penalize job change. Friedberg and Owyang (2004) show that the value of existing jobs is decreasing relative to new jobs, which explains a reduction in expected match duration and thus a loss in the appeal of defined-benefit pension plans.

[4] The incentive to retire early may still exist given a relatively large amount of accumulated pension wealth.

Figure I shows the trend from defined-benefit to defined-contribution plans from 1992 to 2004. The percentage of defined-benefit plans among individual pension holders declined from 53 percent in 1992 to 35 percent by 2004, a decrease of one-third.[5] During this same period, defined-contribution primary plans climbed from 47 percent of private pension holders to 65 percent, a 38 percent increase. Most of the changes in this period occurred between 1992 and 2000.[6] Table I summarizes the mean year values for pension holders, while Table II presents these values for the whole population.

The trends in the composition of private pension types differ when disaggregated by industry sectors as seen in Figure II. While Figure II shows the variation at the more aggregated sector level, this study uses industry variation for identification purposes within the empirical strategy. Examining the trends over time, each sector follows a similar pattern to that of the overall trend of Figure I, with the share of defined-benefit plans declining and the share of defined-contribution plans increasing over time. However, the sectors differ in their initial amounts of each plan type in 1992 and follow different trends, growing at different rates for the shift in pension types.

Also over this time period, the percentage of workers covered by private pensions increased, from 41.4 percent of the population in 1992 to as high as 46.4 percent in 2000 (Table II). Since 2000, the percentage of those covered by private pension plans has declined to 44.5 percent in 2004, for an overall increase of 7.5 percent. This is most likely associated with the

[5] A third type of pension, the combination plan, contains both a defined-benefit and defined-contribution component. All plan types with a defined-benefit component are classified as defined-benefit plans within this study. The percentages of combination plans are relatively small compared with the other two types of plans.

[6] Although the data in Figure I are shown from 1992, these private pension trends can be traced back to at least a decade earlier in the United States. According to Friedberg and Webb (2005), the composition of private pension types has declined from a high of 87 percent of defined-benefit plans in 1983 to 44 percent of the plans in 1998. For a summary of issues related to this transition, see Friedberg and Owyang (2002).

general market downturn after 2000, which may have hindered a firm's decision to offer a pension plan and/or an individual's decision to participate in one.

A THEORETICAL MODEL OF RISK-SHARING

An intuitive way to think about how risk-sharing institutions affect the relative outcomes of individuals is within the context of a formalized theoretical model. I use one such model in this paper from Deaton, Gourinchas, and Paxson (DGP, 2002), because it best describes these relationships. The DGP model uses the example of introducing individual accounts into Social Security as a change in risk-sharing, through which it makes predictions of its effects on the relative differences between individuals. Although there may exist other competing models with their various predicted outcomes, I am uncertain of any which present the necessary arguments as elegantly and as cleanly as this one.[7]

The origins of the DGP model are found deep within the rich consumption literature of economics. The language of the model is based upon the intertemporal choice framework of Deaton (1992), who unified the life-cycle and permanent income hypothesis concepts as two special cases of intertemporal choice. Deaton and Paxson (1994) then used this framework to derive how the variance in consumption evolves over the life-cycle and systematically grows within a group of similar-aged individuals as they age. This concept is derived from data on consumption patterns from the United States, Britain, and Taiwan. Deaton, Gourinchas, and Paxson (2002) then apply these concepts to derive the variance in assets and the effects of risk-sharing arrangements upon it.

The DGP model offers two contributions which are utilized within this study. The first is the derivation of the variance in assets equation, which shows how the variance in assets among

[7] The detailed derivations of the theoretical model are shown in the appendix.

individuals evolves over the life-cycle. The second contribution is predicting how this variance in assets is affected by risk-sharing differences between individuals. This is done through the example of introducing individual accounts to Social Security within the U.S.

This model begins by envisioning a world made up of permanent income consumers with only one type of asset, *A*. The stock of assets evolves from one period to the next through the asset accumulation identity:

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

where *r* is a constant real interest rate, *y* is earnings, and *c* is consumption. Suppose further that earnings follows a stochastic process. In its simplest form, earnings can be thought of as white noise:

$$y_{it} = \mu_i + \varepsilon_{it} = \mu_i + w_t + z_{it} \tag{2}$$

where μ is the individual-specific mean of earnings, ε is the white noise, *w* is a common (macro) component which is *i.i.d.* over time, and *z* is an idiosyncratic component.

The rate of the spread of the variance in assets is then nothing more than the variance of the idiosyncratic component, *z*, of the innovation in earnings. If the idiosyncratic components, *z*, are orthogonal to lagged assets in the cross-section, the cross-sectional variance of assets can then be shown as:

$$\text{var}_t(A) = \text{var}_0(A) + t\cdot\sigma_z^2 \tag{3}$$

where the variance in assets is an increasing function of *t*. Therefore, the variance in assets grows among a cohort as they age together over the life-cycle. This argument need not hold in every year, but it holds on average. Marchand (2007) provides the first empirical evidence to support this theory, finding that the variance in assets grows roughly 1 to 2 percent per each year of age for any given cohort. Comparatively speaking, this variance in assets is found to grow an order of magnitude faster than previous findings on the variance in consumption and in income.

Given the derived variance in assets equation, the risk-sharing system may now be introduced. Assume the government has enacted a simplified social insurance program, where a proportionate tax on earnings, τ, generates a revenue which is divided equally and given to everyone. Our earnings as white noise can now be rewritten with the Social Security tax:

$$y_{it} = (1-\tau)\cdot(\mu_i + \varepsilon_{it}) + \tau\cdot\overline{\mu} = \mu_i - \tau\cdot(\mu_i - \overline{\mu}) + (1-\tau)\cdot z_{it} + w_t \tag{4}$$

The average revenue of the tax redistributed to each individual, $\tau\cdot\overline{\mu}$, providing a shift toward the grand mean (the redistributional effect of Social Security). This redistribution will change the levels associated with everyone not at the mean.

In addition, the inclusion of the risk-sharing component to the Social Security system rescales the original innovation in earnings by $(1 - \tau)$ on the idiosyncratic component, with the macro component, w, left uninsured against. This translates into the variance in assets evolving at $(1 - \tau)^2$ times the original rate:

$$\mathrm{var}_t(A) = \mathrm{var}_0(A) + (1-\tau)^2\cdot t\cdot\sigma_z^2 \tag{5}$$

This shows that a social insurance system limits the rate to which the variance in assets can grow. For example, if the tax is set at 12.4 percent, the variance in assets will spread at 76.7 percent of the original rate.

The Social Security benefit can be thought of as two portions. The first portion is a guaranteed floor that is paid to everyone, irrespective of their earnings or contribution record. The second portion is an individual-specific component, which depends on the present value of their earnings or contributions over their working life. The amount that is divided into each benefit portion is exogenously set by the government. This parameter, φ, can be thought of as the percentage allocated towards the second portion of the Social Security benefit (the individual account). The value of this individual account can be used to purchase an annuity at retirement. With the inclusion of this parameter, it is as if the Social Security tax were reduced by (1 – φ), so that the variance in assets equation can now be expressed as:

$$\mathrm{var}_t(A) = \mathrm{var}_0(A) + [1 - \tau \cdot (1 - \varphi)]^2 \cdot t \cdot \sigma_z^2 \tag{6}$$

This shows that as more of the collected Social Security tax is devoted to individual accounts, the variance in assets will further grow. Within this framework, an increase in the parameter φ will lessen the effect of τ on the variance in assets and will thereby increase this variance in assets by lowering the risk-sharing component of the social insurance system.

EMPIRICAL APPROACH: MEASURING THE EFFECTS OF RISK-SHARING

The theoretical framework displayed the example of introducing individual accounts to a simplified social insurance system. Although the theoretical model shown in this study is based on Social Security, it can alternatively be thought of as a private pension system. Within the context of risk-sharing, 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 would lead to the outcome of greater variance in assets among a given cohort of individuals. However, unlike Social Security, private pensions have already undergone this risk-sharing change. So, only the evolution of private pensions provides the data to empirically test the effects of risk-sharing on the relative differences of individuals.

There are several reasons why the evolution of private pensions can be thought of within the confines of the DGP model. First, the types of benefits are quite similar. Each system contains two types of benefits: one that is defined-benefit and one that is defined-contribution in nature. The normal benefit of a social insurance program works like a defined-benefit plan, where the benefit is based on earnings during working lives and vesting requirements, and the benefit is received as an annuity in retirement. The proposed individual account aspect of the social insurance system is like a defined-contribution plan, where the benefit is based on the performance of the assets within an account, which can then be used to purchase an annuity upon retirement.

Second, the tax or τ in the social insurance system can be thought of as the percentage who have private pensions. As the tax is increased within the DGP model, there is more general risk-sharing and redistribution taking place. As the percentage of those covered by private pensions increases, more general risk-sharing is also apparent. This should be true regardless of pension type. Whether the percentage of either defined-benefit or defined-contribution plans increases for the whole population, it is still an increase in risk-sharing, because it is still sharing more risk across individuals compared with those not participating in a pension plan.

Third, there is the risk-sharing component, φ, in both frameworks. For social insurance, this parameter represents the percentage allocated towards the proposed individual account portion of the benefit. For private pensions, this parameter can be thought of as the percentage of private pensions that are defined-contribution plans. Alternatively, it can also be represented by the amount of defined-benefit plans, but the expectation of the sign on the parameter becomes negative.

Within the DGP model, both τ and φ are assumed to be exogenously determined by the government. That is, both parameters of the risk-sharing mechanism are operating as an external shock, outside of what is happening with the other mechanisms of the variance in assets. This is how the effect of risk-sharing can be isolated and therefore how the effect can be correctly measured. For the evolution of private pensions to fit this description, it must be argued that it too is a risk-sharing change exogenous to other factors affecting the variance in assets.

To measure the effect of risk-sharing on the relative outcomes of individuals, I use the composition of private pension types as a proxy for risk-sharing and the variance in assets as a proxy for the relative economic differences. In order for the risk-sharing variable to be exogenous, it must be shown that it is uncorrelated with the residual term of the variance in assets. Otherwise, this measurement may be confounded by issues of endogeneity, such as potentially omitted variables or simultaneity issues. These potential issues could bias our estimates away from the true causal effect.

In order to address these potential issues, a two-stage least squares procedure is used. For this procedure, an instrument must be found that is highly correlated with the composition of private pension types and uncorrelated with the residual of the variance in assets. Industry indicators provide a good instrument. This instrumentation allows the identification of the true causal effect of risk-sharing on the variance in assets. In short, the industry changes in private pensions are assumed to be uncorrelated with changes in the variance in earnings and in assets. Empirically, industry indicators provide convincing instruments because the change in private pensions is largely a between-industry phenomenon, whereas the residual of the variance in assets is driven by within-industry phenomena that do not significantly differ by industry.[8,9]

[8] The composition of private pension types is well-known to be a between-industry phenomenon, as most if not all of the variation that has taken place can be attributed to between-industry variation. Figure II shows that this variation is substantial between industry sectors. Therefore, industry is highly correlated with the evolution of private pensions and fulfills the first criterion of a good instrument. It has also been extensively discussed in the literature that most of the variance in earnings is driven by within-industry variation, which then determines the innovation in the variance in assets. Wheeler (2005) shows that within-industry components explain 76 to 80 percent of the variance in earnings and 88 to 92 percent of its residual from 1992 to 2002. This finding is supported by Juhn, Murphy, and Pierce (1993) with wage data on earlier periods outside of the analysis in this study and by Card and DiNardo (2002) with evidence regarding skill-biased technological change. Therefore, most if not all of

In the empirical analysis, I test for the strength of these instruments. For both samples, the predictive power of the industry indictors are estimated for each of the risk-sharing proxies:

$$shareDB_{it} = \gamma \cdot Industry + \eta \cdot X_{it} + \varepsilon_{it} \tag{7}$$

$$shareDC_{it} = \lambda \cdot Industry + \eta \cdot X_{it} + \varepsilon_{it} \tag{8}$$

This defines the first stage of the two-stage least squares analysis and allows us to test the claim that industry is highly correlated with the change in private pension types. The *X* variable contains the control variables. Any between-industry variable that may move with the pension change needs to be controlled for in both stages. Unionization membership is one such control that will be used in the analysis, as it may fit this criterion (Fortin and Lemieux 1997). The vector of year indicators is included as well, because it controls for other exogenous (macroeconomic) occurrences unrelated to the risk-sharing process such as market variance.

For this analysis of risk-sharing, it is equally as important to identify what populations will be affected. In the case of Social Security, the whole population is affected by a change in the system, because the whole population is enrolled. However, with private pensions, the pension holders directly affected are only a subset of the whole population. In this study, the impact of risk-sharing on individuals will be examined across pension holders, as well as across the whole population. It may be the case that the effects on the pension holders translate into dissimilar effects for the whole population.

In order to analyze the effect of risk-sharing on the pension holders sample, two separate reduced-form equations are needed, one for each of the pension types. Including both risk-sharing proxies within one equation for the pension holders sample would make the equation

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the residual of the variance in assets is due to within-industry factors, and this is not expected to differ between industries which fulfills the second criterion.

[9] One way to show that the industry changes in private pensions only affect the variance in assets through the risk-sharing effects would be to control for the variance in earnings while regressing the variance in assets on the risk-sharing proxies. This will be shown in a future version of this study.

unidentified. The variance in assets is regressed upon the two different risk-sharing components in the equations:

$$\mathrm{var}_{it}(A) = \alpha + \beta \cdot shareDB_{it} + \eta \cdot X_{it} + \varepsilon_{it} \tag{9}$$

$$\mathrm{var}_{it}(A) = \alpha + \delta \cdot shareDC_{it} + \eta \cdot X_{it} + \varepsilon_{it} \tag{10}$$

where i refers to industry and t refers to the wave year. This is the second-stage of the two-stage least squares regression. For the whole population sample, the variance in assets can then be modeled as a function of risk-sharing between individuals within a given industry, where the variance in assets is regressed upon two different risk-sharing components within the same reduced-form equation:

$$\mathrm{var}_{it}(A) = \alpha + \beta \cdot shareDB_{it} + \delta \cdot shareDC_{it} + \eta \cdot X_{it} + \varepsilon_{it} \tag{11}$$

The X variable for each sample contains the control variables, including the percentage of union membership, a vector of year dummies, and in some specifications, a vector of industry sector fixed effects. Again, the vector of year indicators controls for other exogenous occurrences unrelated to the risk-sharing process such as market variance.

The main hypothesis to test here is whether the theoretical relationship between the variance in assets on risk-sharing, as shown in equation (6), is significant. The sign of the coefficient on each of our risk-sharing proxies in the second stage must also coincide with the correct intuition. The coefficient on $shareDB_{it}$, β, can be thought of as a decrease in the parameter φ. Therefore, this coefficient is expected to be negative, as defined-benefit plans are associated with more risk-sharing and should reduce the variance in assets. The coefficient on $shareDC_{it}$, δ, is hypothesized to be positive. This is a case of decreasing risk-sharing, so the variance in assets among a cohort of individuals should rise with a growth in the share of defined-contribution plans. The magnitudes of these risk-sharing coefficients are also of interest, as they provide the answers to how large an impact risk-sharing has on each of the samples.[10]

DATA

The asset data, which are used to construct the dependant variable within this study, come from the Health and Retirement Study. This is a longitudinal household survey for those over the age of fifty in the United States.[11] The Health and Retirement Study contains detailed information on these households regarding assets, pensions, and employment. There are seven completed waves of the HRS, which has been conducted every other year from 1992 to 2004. The main asset definition used here is total net assets (or net worth), which is derived from the RAND version of the HRS data.[12] These data provide the advantages of standardized asset definitions and a wave-consistent imputation method.[13]

Total net assets are defined as the net marketable value of total wealth calculated by the sum of all wealth components less all debt. Whereas the theoretical framework has derived the variance in assets according to one general asset class, this study will use the aggregated total net assets. I use net assets, including debt, to make this an asset concept that best represents the well-being of a household. Assets are a good representation of differences in the well-being or

[10] For the pension holders sample, the risk-sharing coefficients are the pure effect of φ, as τ is set equal to 1. For the whole population sample, however, the risk-sharing coefficients contain the effects of both φ and τ, as they need to be multiplied together to obtain the representative composition of private pensions. Therefore, any interpretation of these coefficients will need to include the effects of both mechanisms.
[11] The Health and Retirement Study public use dataset, 1992-2004, is produced and distributed by the University of Michigan, Ann Arbor, MI, with funding from the National Institute on Aging (grant number NIA U01AG009740).
[12] The RAND HRS Data, Version F, May 2006, is produced by the RAND Center for the Study of Aging, Santa Monica, CA, with funding from the National Institute on Aging and the Social Security Administration.
[13] The RAND version of the HRS data contains imputations of all asset types using a consistent method, while the original HRS public release files use a simple hot-deck imputation method for many asset types, which is inconsistent across waves. For more information on the RAND imputations, see the RAND HRS Data Documentation, Version F, May 2006, 24 -32.

outcomes between individuals, as they are regarded as the storage vehicle for future consumption and their differences vary more than those in consumption.

The wealth components that make up total net assets are the net values of: primary residence, which takes into account all mortgages and other home loans on the primary residence, other real estate, vehicles, businesses, IRA and Keogh accounts, stocks, mutual funds, investment trusts, checking, savings, money market accounts, certificates of deposit, government savings bonds, T-bills, bonds and bond funds, and all other savings, less the value of all other debt. All of these wealth components are valued in nominal U.S. dollars. The imputed present values of both defined-benefit and defined-contribution pension wealth are also taken into account.[14]

In addition, assets are listed at the household-level in the HRS and are reported by the financial respondent of each household. Therefore, the amount of household assets is the same for each individual within a household of more than one individual. Because calculating the variance in asset in this study requires as many observations as possible in order to be accurate, every respondent within a household is treated separately and is then grouped into their respective industries.

Assets are transformed by two processes prior to calculating their variance: the natural logarithm and the inverse hyperbolic sine. Both transformations are used to mute the effects of outliers in the estimation process. The natural logarithm, however, drops all non-positive observations of assets for which the logarithm would be unidentified. Because these negative or

[14] However, because these imputations are only available for both types of pensions in two waves (1992 and 1998), I use the total assets excluding pension wealth as my primary dependant variable for the analysis.

zero asset observations are important regarding the well-being of households, the inverse hyperbolic sine of assets is also taken, which then incorporates all non-positive observations.[15]

The variances in these asset transformations are then calculated over individuals within their respective industries. This is done by collapsing the asset data by the most detailed industry code available in the HRS: the 3-digit 1980 Census Industry Classification code available through a restricted-access HRS data product.[16] Using the most specific industry codes in the HRS allows for a greater number of industry-year observations for the analysis, as the number of unmasked industry codes in the restricted data far exceeds the number of masked industry codes in the public data. These restricted access industry codes are merged with the rest of the HRS data using individual identification codes. An individual's industry of current employment is used for the industry identification. When a current industry was not reported by the individual, the industry of their longest employment duration is used.

The pension plan data, used to compute the composition of pension plan types, come directly from the employer-provided Form 5500 data compiled by the Center for Retirement Research at Boston College.[17] These data are not aggregations of self-reported pension data, which could be calculated using the HRS data source. Rather, these are actual counts of the number of pension plans, which are calculated by each pension type (defined-benefit, defined-contribution plans, and combination plans) and are provided by employers to the U.S.

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[15] The inverse hyperbolic sine transformation, which is both symmetric and approximately linear about the origin, can be represented by the following equation from Burbidge, Magee, and Robb (1988):

$$\theta^{-1} \cdot \sinh^{-1}(\theta \cdot A) = \theta^{-1} \cdot \ln(\theta \cdot A + (\theta^2 \cdot A^2 + 1)^{1/2}) \qquad (12)$$

where θ is a scaling parameter estimated by maximum likelihood. Previous studies have set θ equal to 0.0001 and this study adopt this value as well. For more details on the IHS transformation and its application, see Pence (2006). For a different application of the IHS transformation, see Bucks and Moore (2006).

[16] HRS Restricted Data, Industry/Occupation, Version 5.0, April 2006.

[17] A special thanks to Mauricio Soto and the Center for Retirement Research at Boston College for providing these pension plan data by industry code. Detailed information on this data can be found in Buessing and Soto (2006).

Department of Labor.[18] Using the self-reported data would subject the analysis to criticisms regarding measurement error, due to the misreporting of pension types and compositional differences resulting from the aggregation of individuals.[19] These Form 5500 data are calculated by industry and are then linked to the HRS asset data using a common industry code.[20]

An additional source of data, the Current Population Survey, is used to calculate the percentage of private pensions holders for the whole population and the percentage that are union members.[21] The value of the percentage that hold private pensions is used to transform the Form 5500 values (for the pension holding population) into the percentage that hold each of these types of pensions for the whole population sample. This is done by multiplying these variables together. The percentage of union membership is also calculated for the whole population using the CPS. These numbers are then multiplied by the percentage that hold private pensions for use within the pension holders sample. Again, all of the CPS data are collapsed to and calculated by a common industry code, which is used to link the data to both the HRS asset data and the Form 5500 pension composition data.[22]

EVIDENCE OF THE EFFECTS OF RISK-SHARING ON ASSETS

Tables I and II present the summary statistics in the form of wave means for the pension holders sample and the whole population sample respectively. Each sample contains 235 to 245 industry

[18] As stated earlier, combination plan types are classified as defined-benefit within this study.
[19] For a discussion regarding the differences between self-reported and employer-provided pension data, see Chan and Stevens (2003, 2004).
[20] The Form 5500 data uses the 1987 Standard Industry Classification (SIC) industry codes from 1992 to 1997, the 1997 North American Industry Classification System (NAICS) industry codes from 1998 to 2001, and the 2002 NAICS from 2002 to present. These alternative industry codes are converted and matched to the 1980 CIC codes by the author.
[21] The CPS does not contain pension type information but does contain pension coverage information.
[22] The CPS, like the HRS, uses the Census Industry Classification (CIC) 3-digit code. However, the HRS uses the 1980 CIC codes in all years, while the CPS uses the 1990 CIC codes from 1992 to 2002 and the 2002 CIC codes from 2003 to present. These later CIC codes are converted and matched to the earlier 1980 CIC codes by the author.

observations within a wave. However, the pension holders sample contains fewer individuals in a single industry-year observation relative to the whole population sample. The variance in assets is higher on average for the whole population than for the pension holders sample, which is as expected. The variance in assets also steadily grows over time in both samples. Including individuals with non-positive assets increases the variance in assets in the pension holders sample and decreases this variance in the whole population sample, as seen by comparing the log transformations with the IHS transformations. Including pension wealth greatly decreases the variance in assets for both samples, though there are relative few individual observations within these calculations.

The first stage results of the analysis are presented in Table III. Industry is a strong predictor of the composition of private pension types in both samples. Industry explains between 84 and 87 percent of the variation in each plan type for pension holders. For the whole population, industry explains 87 to 91 percent of the variation in the percentage of defined-benefit plans and 69 to 76 percent of the variation in the percentage of defined-contribution plans.

The results for the effect of risk-sharing on the variance in assets are shown for pension holders in Tables IV and V and Figure III. The level effects and elasticities for the variance in the logarithm of assets are compared in Table IV. All coefficients on the risk-sharing proxies are statistically significant at the 1 percent level and are in-line with the predictions of the model. That is, the coefficients are negative on the percentage of defined-benefit plans and positive for the percentage of defined-contribution plans. This is as expected, as defined-benefit plans are associated with more risk-sharing and defined-contribution plans are associated with less risk-sharing. More risk-sharing reduces the variance in assets and, in turn, differences across individuals, while less risk-sharing increases the variance in assets and these differences. The negative coefficient on the percentage of union membership is also in-line with the literature, as unions are associated with wage compression. The year indicators are statically significant and positive in years of increased market volatility.

These relationships are visually shown for the elasticity effect in Figure III. The x-axis represents the composition of each plan type with the elasticity of the variance in assets on the y-axis. Moving from right to left in the upper portion of Figure III, the percentage of defined-benefit plans declines and the variance in assets increases. Moving from left to right in the lower portion of Figure III, the percentage of defined-contribution plans increases and the variance in assets increases along with it.

The elasticities of different variance in assets definitions and specifications are compared for the pension holders sample in Table V. Including non-positive asset observations under the IHS transformation yields larger coefficients on our risk-sharing proxies, while controlling for sector fixed effects slightly reduces these coefficients. Union membership is not significant under the IHS transformation or with the inclusion of sector fixed effects. Among the two-stage least squares estimates, the elasticities on the risk-sharing proxies range from -0.46 to -0.56 for defined-benefit plans and 0.46 to 0.56 for defined-contribution plans. Using these estimates for both plan types, this means that a 10 percent reduction in defined-benefit plans together with a 10 percent rise in defined-contribution plans would lead to an asset variance increase between 9.2 and 11.2 percent, which is a one-for-one relationship on average.

The results for the effect of risk-sharing on the variance in assets are shown for the whole population sample in Tables VI and VII and Figure IV. The level effects and elasticities for the variance in the logarithm of assets are compared in Table VI. The risk-sharing proxy of the percentage of defined-benefit plans is negative and statistically significant at the 1 percent level, which supports the predictions of our theoretical model. Because defined-benefit plans are associated with more risk-sharing, an increase in the percentage that have defined-benefit plans would lead to an asset variance reduction. The risk-sharing proxy of the percentage of defined-contribution plan changes is negative in every specification. This is not in-line with the predictions of the model: an increase in defined-contribution plans is expected to increase the variance in assets, not decrease it. The statistical significance does, however, change slightly across the specifications. The coefficient on union membership is positive, which is not predicted in the literature, though it is also changing in its statistical significance. The year indicators are positive and mostly statistically significant, which is again associated with increased market volatility.

These relationships are also visually shown in Figure IV. The x-axis again represents the composition of each plan type and the elasticity of the variance in assets is shown on the y-axis. Moving from right to left in the upper portion of Figure IV, the percentage of defined-benefit plans declines and the variance in assets increases. This trend for defined-benefit plans is steeper for the whole population sample than for the pension holders sample. Moving from left to right in the lower portion of Figure IV, the percentage of defined-contribution plans increases and the variance in assets slightly decreases, and this trend is fairly level. This differs from the reciprocal trend for the pension holders sample.

The elasticities of different variance in assets definitions and specifications are compared for the whole population sample in Table VII. Including non-positive asset observations under the IHS transformation yields smaller coefficients on the risk-sharing proxies. Controlling for sector fixed effects increases the defined-benefit coefficient while slightly reducing the defined-contribution coefficient. Union membership is statistically significant under the IHS transformation and marginally significant with the inclusion of sector fixed effects. Among the two-stage least squares estimates, the elasticities on the defined-benefit risk-sharing proxy range from -0.61 to -1.45. The elasticities on the defined-contribution risk-sharing proxy range from -0.39 to -0.78. Using these estimates for both plan types, this means that a 10 percent reduction in defined-benefit plans together with a 10 percent increase in defined-contribution plans will increase asset variance between 2.2 and 8.6 percent.

The results for several alternative specifications are shown in Table VIII. First, the business assets are excluded from the asset definition. This exclusion decreases the mean and variance in assets. Also, the magnitudes of the coefficients and elasticities in the risk-sharing analysis are reduced, but there are no sign changes present nor is there any loss of statistical significance. The second alternative specification includes the pension wealth imputations in the asset definition. As previously shown in Tables I and II, this inclusion increases the average amount of assets while greatly reducing the variance in assets.[23] Including the pension wealth imputations did not change the signs of any of the risk-sharing coefficients in the analysis. However, the inclusion of pension wealth does decrease the magnitudes of the risk-sharing coefficients on average. Also, these risk-sharing coefficients are not statistically significant in most cases due to the decreased sample sizes. Third, mean assets are controlled for while estimating the effects of risk-sharing on the variance in assets.[24] Because this analysis deals with the second moment, it may be a concern that the first moment is driving the results. The sign on the coefficient of mean assets is positive and statistically significant throughout the

[23] Similarly, the inclusion of Social Security wealth could have the same effect of increasing the mean of assets and reducing the variance in assets. However, while the inclusion of private pension wealth and Social Security wealth lowers the overall variance in assets, the variances of each of the components themselves are not zero.

[24] The controlling of the first moment while evaluating the effects upon the second moment assumes a normal distribution of assets.

specifications. This specification led to a slight reduction in the risk-sharing coefficients. The inclusion of the first moment did not, however, change the sign or the statistical significance of the risk-sharing coefficients.

Comparing the overall evidence among pension holders and the whole population, it is clear that a shift in private pension types has a larger impact on pension holders than on the whole population, which is expected. In addition, the effect of risk-sharing as measured through defined-benefit plans reduces asset variance for both the pension holders and the whole population. This effect is larger for the whole population than for pension holders, which stresses that the benefits of general risk-sharing may be even greater for those outside of the pension holding population.[25]

In terms of defined-contribution plans, the pension change reduces asset variance for the whole population, which is unexpected, but increases asset variance among pension holders, which is in-line with the predictions of the theoretical model. Within the context of the model, however, the whole population *is* the pension holding population. So, the model makes no predictions as to what would happen to those who are not pension holders. Therefore, the asset reduction for the whole population resulting from defined-contribution plans does not necessarily contradict the predictions of the model. This finding may actually result from the rise in private pension coverage over this period, which could be associated with greater risk-sharing across individuals regardless of pension type.[26] One possible explanation for this may be that the

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[25] It is important to note that the average tenure in pension plans also differs between samples and plan types. For the pension holders sample, the average plan tenure is 16.5 years for defined-benefit holders and 9.4 years for defined-contribution holders. For the whole population sample, the average plan tenure for defined-benefit holders is also slightly less than doubled that of defined-contribution holders at 20.1 years and 11.9 years, respectively.

[26] This can be attributed to the effect of τ in the whole population sample, as described in the Empirical Approach section of this paper.

parameters set for retirement saving within a pension plan help equalize assets across individuals.

DISCUSSION

The primary purpose of this study has been to identify the effects of risk-sharing arrangements on the relative outcomes of individuals. In doing so, I have identified one unique outcome of the change in private pensions. As demonstrated using empirical evidence, the private pension shift from defined-benefit to defined-contribution plans has increased the relative economic differences between individuals through the increased variance in their collective assets. Using these estimates for both plan types, a ten percent reduction in defined-benefit plans together with a ten percent rise in defined-contribution plans will lead to an asset variance increase between 9.2 and 11.2 percent for pension holders and between 2.2 and 8.6 percent for the whole population. This evidence is in-line with the predictions of the theoretical model: the variance in assets rises as risk-sharing among individuals is being undone.

The findings for private pensions in this study can provide insight for other risk-sharing arrangements in the changing retirement landscape of the United States. For example, these results may be generalized to predict the possible effects of introducing individual accounts to Social Security. Based on the private pension results, this type of change to Social Security may theoretically lead to a similar increase in the relative economics differences across individuals, due to the decreased risk-sharing among individuals. This is true regardless of whether the individual accounts are an ‘add-on’ to the traditional defined-benefit nature of Social Security or a ‘carve-out,’ because it is the whole of Social Security that is important. Furthermore, because nearly every citizen is a pension holder under Social Security, the number of people affected by a change in Social Security would be much greater than those currently affected by the shift in private pensions.

Further implications of these findings may depend on the make-up of retirement income security of the household. Consider three types of households: those who solely rely on Social Security to fund their retirement (mostly lower income individuals), those that rely on private pensions and Social Security for retirement (but with little to no private savings), and those with all three legs of retirement income security represented (private savings, private pensions, and Social Security). For those relying on all three legs of retirement income security, the findings suggest that these households may not be adjusting their portfolios according to the increased risk exposure in private pensions. If these households did offset the increased risk in private pensions by taking on less risk in their private savings, there may be no overall increase in the variance in assets among this group. This is not shown to be the case, perhaps reflecting either a better fit of relative risk aversion with the increased risk or inaction alone. For those that rely on both private pensions and Social Security to fund their retirement, the findings suggest that a similar change to Social Security, in addition to that in private pensions, might further exacerbate the issue of unwanted risk among this group the most. These households would be 'hit twice' and would not be able to offset the increased risk in their portfolios due to a lack of private savings. For those that solely rely on Social Security to fund their retirement, the introduction of individual accounts may be an advantage, as these households would now be given the opportunity to take on more risk if wanted. The argument for diversification would be pitted against the argument for the traditional role of Social Security in this case.

In closing, one retirement income vehicle should not be viewed in a vacuum. If the evolution of private pensions increases asset variance, then a further increase in this variance as a result of introducing individual accounts to Social Security would not help equalize the economic outcomes of individuals. From a general policy perspective, some of the good outcomes may be sacrificed, in order to avoid some of the bad outcomes, which is the essence of social insurance institutions. The risk-sharing role of Social Security in the United States may therefore be promoted as a hedge to offset the decreased risk-sharing and increased individual risk associated with the evolution of private pensions.

APPENDIX: DERIVING THE THEORETICAL MODEL

Deriving the variance in assets equation

The theoretical framework is constructed primarily from Deaton, Gourinchas, and Paxson (2002), with supporting roles from Deaton (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. The stock of assets evolves from one period to the next in the asset accumulation identity:

$$A_t = (1+r)\cdot(A_{t-1} + y_{t-1} - c_{t-1}) \tag{A1}$$

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

$$\sum_{1}^{T} \frac{c_t}{(1+r)^t} = A_1 + \sum_{1}^{T} \frac{y_t}{(1+r)^t} \tag{A2}$$

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:

$$c_t = \frac{r}{1+r}\cdot A_t + \frac{r}{1+r}\cdot \sum_{k=0}^{\infty} \frac{1}{(1+r)^k} E_t(y_{t+k}) \tag{A3}$$

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:

$$\Delta c_t = \eta_t \equiv \frac{r}{1+r}\cdot \sum_{k=0}^{\infty} \frac{1}{(1+r)^k} (E_t - E_{t-1}) y_{t+k} \tag{A4}$$

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

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

$$s_t = y_t^d - c_t = \left[\frac{r}{1+r}\cdot A_t + y_t\right] - c_t \tag{A5}$$

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

$$s_t = -\sum_{k=1}^{\infty} \frac{1}{(1+r)^k} E_t \Delta y_{t+k} \tag{A6}$$

and subsequently assets are linked to savings by:

$$\Delta A_t = (1+r)\cdot s_{t-1} \tag{A7}$$

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

$$\alpha(L)(y_t - \mu) = \beta(L)\varepsilon_t \tag{A8}$$

then explicit forms for the innovation to consumption can be derived. Consumption can now be seen as a random walk:

$$\Delta c_t = \eta_t = \frac{r}{1+r} \cdot \frac{\beta\left(\frac{1}{1+r}\right)}{\alpha\left(\frac{1}{1+r}\right)} \cdot \varepsilon_t \tag{A9}$$

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

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

$$y_{it} = \mu_i + \varepsilon_{it} = \mu_i + w_t + z_{it} \tag{A10}$$

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 rewritten as:

$$c_{it} = c_{it-1} + \frac{r}{1+r} \cdot (w_t + z_{it}) \tag{A11}$$

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

$$\text{var}_t(c) = \text{var}_{t-1}(c) + \frac{\sigma_z^2 r^2}{(1+r)^2} = \text{var}_0(c) + \frac{t\sigma_z^2 r^2}{(1+r)^2} \tag{A12}$$

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:

$$s_{it} = \frac{\varepsilon_{it}}{1+r} \tag{A13}$$

$$A_{it} = A_{it-1} + \varepsilon_{it-1} \tag{A14}$$

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

$$\Delta y_{it}^d = \frac{r\varepsilon_{it}}{1+r} + \frac{\varepsilon_{it}}{1+r} - \frac{\varepsilon_{it-1}}{1+r} = \varepsilon_{it} - \frac{\varepsilon_{it-1}}{1+r} \tag{A15}$$

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

$$\text{var}_t(y^d) = \text{var}_{t-1}(y^d) + \frac{\sigma_z^2 r^2}{(1+r)^2} = \text{var}_0(y^d) + \frac{t\sigma_z^2 r^2}{(1+r)^2} \tag{A16}$$

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:

$$\text{var}_t\, y = \sigma_\mu^2 + \sigma_z^2 = (constnt) \tag{A17}$$

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

$$\text{var}_t(A) = \text{var}_0(A) + t \cdot \sigma_z^2 \tag{A18}$$

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.

Introducing the risk-sharing component

The following shows how a risk-sharing system decreases the spread of inequality among individuals in income, consumption, and assets, which is again attributed to Deaton, Gourinchas, and Paxson (2002). 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:

$$y_{it} = (1-\tau)(\mu_i + \varepsilon_{it}) + \tau\bar{\mu} \tag{A19}$$

$$y_{it} = \mu_i - \tau(\mu_i - \bar{\mu}) + (1-\tau)\varepsilon_{it} \tag{A20}$$

$$y_{it} = \mu_i - \tau(\mu_i - \bar{\mu}) + (1-\tau)z_{it} + w_t \tag{A21}$$

where τ is introduced to the same form of earnings as in equation (A10) while deriving the variance in assets. The last term, $\tau\bar{\mu}$, is the average revenue of the tax that is redistributed to each individual. Compared with the original earnings process, there is now a shift toward the grand mean, which is the redistributional effect of Social Security. This is done together with a rescaling of the innovation by $(1 - \tau)$, which is the risk-sharing component of Social Security. This redistribution will change consumption levels for everyone not at the mean, but will not affect the innovation of the variance equations (A12, A16, A17, and A18), 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:

$$\text{var}_t(A) = \text{var}_0(A) + (1-\tau)^2 \cdot t \cdot \sigma_z^2 \tag{A22}$$

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:

$$\Delta c_{it} = \frac{r}{1+r} \cdot \left[w_t + (1-\tau) \cdot z_{it}\right] \tag{A23}$$

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

$$y_{it} = (1-\tau) \cdot (\mu_i + \varepsilon_{it}) = (1-\tau) \cdot \mu_i + (1-\tau) \cdot (w_t + z_{it}) \tag{A24}$$

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

$$\frac{R\tau(\mu + w_{R+s})}{T-R} \tag{A25}$$

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 by retirement, or to the rate at which the various inequality spread.

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 an individual-specific component and depends on the present value of earnings (or contributions) over the working life. Then:

$$S_i = G + V_i = G + \tilde{\alpha}\sum_{j=1}^{R-1} y_{ij}^b (1+r)^{R-j} = G + \alpha\sum_{j=1}^{R-1} y_{ij}(1+r)^{R-j} \quad \text{(A26)}$$

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 United States, 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:

$$\tau\sum_{j=1}^{R-1}\sum_{i=1}^{N} y_{ij}^b (1+r)^{R-j} = \tau\sum_{j=1}^{R-1} Y_t (1+r)^{R-j} \quad \text{(A27)}$$

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:

$$\sum_{i=1}^{N}\sum_{j=R}^{T}(1+r)^{R-j}\left[G + \tilde{\alpha}\sum_{j=1}^{R-1} y_{ij}^b (1+r)^{R-j}\right] \quad \text{(A28)}$$

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

$$G + \tilde{\alpha}\bar{y}^* = \frac{\tau\bar{y}^*}{\sum_{j=R}^{T}(1+r)^{R-j}} \quad \text{(A29)}$$

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

$$\bar{y}^* = \frac{1}{N}\sum_{j=1}^{R-1} Y_j (1+r)^{R-j} \quad \text{(A30)}$$

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

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

$$\varphi = \frac{\tilde{\alpha}}{\tau}\sum_{j=R}^{T}(1+r)^{R-j} \quad \text{(A31)}$$

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 in 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:

$$G = \frac{\bar{y}^*\tau(1-\varphi)}{\sum_{j=R}^{T}(1+r)^{j-R}} \quad \text{(A32)}$$

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

$$S_i = \frac{\tau}{\sum_{j=R}^{T}(1+r)^{R-j}}\left[(1-\varphi)\bar{y}^* + \varphi\sum_{j=1}^{R-1} y_{ij}^b (1+r)^{R-j}\right] \quad \text{(A33)}$$

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:

$$\mathrm{var}_t(A) = \mathrm{var}_0(A) + [1-\tau\cdot(1-\varphi)]^2 \cdot t \cdot \sigma_z^2 \quad \text{(A34)}$$

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.

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.

Barr, Nicholas and Diamond, Peter. 2006. "The Economics of Pensions." *Oxford Review of Economic Policy*, Vol. 22, No. 1, 15 – 39.

Bodie, Zvi, Marcus, Alan, and Merton, Robert. 1988. "Defined Benefit vs. Defined Contribution Pension Plans: What are the Real Trade-Offs?." In Z. Bodie, J. Shoven, and D. Wise, eds., *Pensions in the U.S. Economy*, Chicago, University of Chicago Press.

Burbidge, John B., Magee, Lonnie, and Robb, A. Leslie. 1988. "Alternative Transformations to Handle Extreme Values of the Dependent Variable." *Journal of the American Statistical Association*, Vol. 83, No. 401, 123–127.

Bucks, Brian and Moore, Kevin. 2006. "Measuring the Role of Self-Employment in Earnings Inequality." International Association of Income and Wealth 29th General Conference Paper.

Buessing, Marric and Soto, Mauricio. 2006. "The State of Private Pensions: Current 5500 Data." Center for Retirement Research at Boston College Issue in Brief No. 42. Feb.

Burtless, Gary. 2003. "What Do We Know About the Risk of Individual Account Pensions? Evidence from Industrial Countries." *American Economic Review*, Vol. 93, No. 2, 354-359.

Card, David and DiNardo, John E. 2002. "Skill-Biased Technological Change and Rising Wage Inequality: Some Problems and Puzzles." *Journal of Labor Economics*, Vol. 20, No. 4, 733-783.

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, 1307-1333.

Copeland, Craig. 2000. "Pension Coverage: Examining CPS Data." Employee Benefits Research Institute Notes, Sept., 4-9.

Deaton, Angus. 1992. *Understanding Consumption*. Oxford, Clarendon Press. 242 pages.

Deaton, Angus and Paxson, Christina. 1994. "Intertemporal Choice and Inequality." *Journal of Political Economy*, Vol. 102, No. 3, 437-467.

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, 115-148.

Even, William and Macpherson, David. 2007. "Defined Contribution Plans and the Distribution of Pension Wealth." *Industrial Relations*, Vol. 46, No. 3, July, 551-581.

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, 23-34.

_____ . 2004. "Explaining the Evolution of Pension Structure and Job Tenure." NBER Working Paper No. 10714.

Friedberg, Leora and Webb, Anthony. 2005. "Retirement and the Evolution of Pension Structure." *Journal of Human Resources*, Vol. 40, No. 2, 281-308.

Fortin, Nicole M. and Lemieux, Thomas. 1997. "Institutional Changes and Rising Wage Inequality: Is There a Linkage." *Journal of Economic Perspectives*, Vol. 11, No. 2, 75-96.

Gale, William G., Shoven, John B., Warshawsky, Mark J. (eds.). 2005. *The Evolving Pension System: Trends, Effects, and Proposals for Reform*. Washington, DC, Brookings Institution. 226 pages.

Hohaus, R. A. 1962. "Retirement Income Protection." *Best's Insurance News*, Vol. 63, No. 4, 21.

Juhn, Chinhui, Murphy, Kevin, and Pierce, Brooks. 1993. "Wage Inequality and the Rise in Returns to Skill." *Journal of Political Economy*, Vol. 101, No. 3, 410-442.

Marchand, Joseph T. 2007. "Aging and Assets: Revisiting Intertemporal Choice and Inequality with Household Asset Data." Working paper.

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, 1-15.

Nataraj, Sita and Shoven, John B. 2003. "Comparing the Risks of Social Security with and without Individual Accounts." *American Economic Review*, Vol. 93, No. 2, 348-353.

Nathan, Richard P. (ed.). 2006. "Would Private Accounts Improve Social Security?: Point/Counterpoint." With Jeffrey R. Brown in the affirmative and Kenneth S. Apfel in the negative. *Journal of Policy Analysis and Management*, Vol. 25, No. 3, 679 – 690.

Papke, Leslie E. 1999. "Are 401(k) Plans Replacing Other Employer-Provided Pensions? Evidence from Panel Data." *Journal of Human Resources*, Vol. 34, No. 2, 346-368.

Pence, Karen M. 2006. "The Role of Wealth Transformations: An Application to Estimating the Effect of Tax Incentives on Saving." *Contributions to Economic Analysis & Policy*, Vol. 5, No. 1, Article 20.

Pension Research Council. 2005. "The Evolution of Risk and Reward Sharing in Retirement." Pension Research Council Working Paper # 2005-6. May.

Poterba, James, Rauh, Joshua, Venti, Steven, and Wise, David. 2007. "Defined Contribution Plans, Defined Benefit Plans, and the Accumulation of Retirement Wealth." NBER Working Paper #12597.

Samwick, Andrew A. and Skinner, Jonathan S. 2004. How Will 401(k) Pension Plans Affect Retirement Income?" American Economic Review, Vol. 94, No. 1, March, 329-343.

Shiller, Robert. 2003. "Social Security and Individual Accounts as Elements of Overall Risk-Sharing." *American Economic Review*, Vol. 93, No. 2, 343-347.

Wheeler, Christopher H. 2005. Evidence on Wage Inequality, Worker Education, and Technology." *Federal Reserve Bank of St. Louis Review*, Vol. 87, No. 3, 375-393.

Wolff, Edward N. 2003. "The Devolution of the American Pension System: Who Gained and Who Lost?" *Eastern Economic Journal*, Vol. 29, No. 4, 477-495.

Table I
Summary Statistics for the Pension Holders Sample, Wave Means

			Total Net Assets (excl. Pension Wealth)			Total Net Assets (incl. Pension Wealth)		Pension Related Variables			
Wave	Industry Count	Individuals within an Industry Count	Mean	Variance of Log	Variance of IHS	Mean	Variance of Log	% PH	% DB	% DC	% Union Members
1992	245	25.2	213,340	1.63	1.83	390,006	0.79	100.0	52.7	47.3	7.6
1994	245	23.5	262,607	1.70	1.77	.	.	100.0	48.1	51.9	7.5
1996	245	22.6	272,611	1.84	1.85	.	.	100.0	44.7	55.3	7.2
1998	245	26.4	313,518	1.93	2.26	628,627	0.97	100.0	41.6	58.4	6.8
2000	245	24.9	359,099	2.13	2.13	.	.	100.0	35.6	64.4	6.5
2002	245	23.0	371,782	1.95	2.10	.	.	100.0	35.5	64.5	6.4
2004	235	26.2	465,010	2.14	2.28	.	.	100.0	35.1	64.9	5.6

Source: Author's calculations from the Health and Retirement Study, Current Population Survey, and Form 5500 data.

Table II
Summary Statistics for the Whole Population Sample, Wave Means

Wave	Industry Count	Individuals within an Industry Count	Total Net Assets (excl. Pension Wealth) Mean	Total Net Assets (excl. Pension Wealth) Variance of Log	Total Net Assets (excl. Pension Wealth) Variance of IHS	Total Net Assets (incl. Pension Wealth) Mean	Total Net Assets (incl. Pension Wealth) Variance of Log	Pension Related Variables % PH	Pension Related Variables % DB	Pension Related Variables % DC	% Union Members
1992	245	119.6	219,266	2.22	2.16	374,284	0.80	41.4	24.3	15.9	13.8
1994	245	119.6	250,337	2.36	2.22	.	.	42.5	23.3	18.0	13.5
1996	245	119.5	297,746	2.60	2.36	.	.	44.3	22.7	20.3	12.5
1998	245	119.5	302,820	2.81	2.59	630,141	0.97	44.8	21.6	22.4	12.0
2000	245	119.6	355,077	2.88	2.54	.	.	46.4	19.3	26.2	11.5
2002	245	119.6	376,810	3.08	2.66	.	.	46.2	19.3	25.9	11.0
2004	235	118.9	432,148	3.15	3.00	.	.	44.5	18.7	25.9	9.8

Source: Author's calculations from the Health and Retirement Study, Current Population Survey, and Form 5500 data.

Table III
First Stage: Industry Indicators as Predictors of the Composition of Private Pensions

	Pension Holders Sample				Whole Population Sample			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependant Variable	% DB	% DB	% DC	% DC	% DB	% DB	% DC	% DC
Industry Indicators	X	X	X	X	X	X	X	X
% Union Members		X		X		X		X
Year Indicators		X		X		X		X
Partial F-stat	22.84	28.61	22.84	28.61	55.82	36.57	12.84	18.16
Partial R-squared	0.84	0.87	0.84	0.87	0.91	0.87	0.69	0.76
observations	806	766	806	766	1,449	1,419	1,449	1,419

Source: Author's calculations from the Health and Retirement Study, Current Population Survey, and Form 5500 data.

Table IV
Effect of Risk-Sharing on the Variance in Assets for Pension Holders Sample

	Variance in Log of Assets – Level Effect				Variance in Log of Assets – Elasticity			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
% DB Holders	-1.145	-1.198	-0.834	-0.997	-0.592	-0.624	-0.396	-0.488
(run separate)	(0.199)	(0.218)	(0.232)	(0.249)	(0.102)	(0.112)	(0.117)	(0.126)
% DC Holders	1.145	1.198	0.834	0.997	0.592	0.624	0.396	0.488
(run separate)	(0.199)	(0.218)	(0.232)	(0.249)	(0.102)	(0.112)	(0.117)	(0.126)
% Union Mem			-1.260	-1.107			-0.677	-0.591
			(0.582)	(0.589)			(0.295)	(0.298)
D_1994			0.061	0.052			0.025	0.020
			(0.185)	(0.185)			(0.094)	(0.094)
D_1996			0.088	0.073			0.081	0.073
			(0.189)	(0.190)			(0.096)	(0.096)
D_1998			0.172	0.152			0.154	0.143
			(0.182)	(0.182)			(0.091)	(0.092)
D_2000			0.400	0.374			0.226	0.211
			(0.188)	(0.189)			(0.095)	(0.095)
D_2002			0.163	0.140			0.035	0.022
			(0.195)	(0.195)			(0.098)	(0.099)
D_2004			0.326	0.301			0.202	0.188
			(0.182)	(0.183)			(0.092)	(0.093)
R-squared	0.04	0.04	0.05	0.05	0.04	0.04	0.06	0.06
observations	806	806	766	766	806	806	766	766

Source: Author's calculations from the Health and Retirement Study, Current Population Survey, and Form 5500 data. Standard errors in parentheses.

Table V
Effect of Risk-Sharing on the Variance in Assets: Comparing Elasticities for Pension Holders

	Variance in Log of Assets – Elasticity		Variance in IHS of Assets – Elasticity		Variance in Log of Assets – Elasticity (w/ Sector f.e.)	
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	2SLS	OLS	2SLS	OLS	2SLS
% DB Holders	-0.396	-0.488	-0.463	-0.563	-0.336	-0.462
(run separate)	(0.117)	(0.126)	(0.111)	(0.119)	(0.139)	(0.154)
% DC Holders	0.396	0.488	0.463	0.563	0.336	0.462
(run separate)	(0.117)	(0.126)	(0.111)	(0.119)	(0.139)	(0.154)
% Union Mem	-0.677	-0.591	-0.155	-0.060	-0.547	-0.494
	(0.295)	(0.298)	(0.278)	(0.281)	(0.333)	(0.335)
D_1994	0.025	0.020	-0.069	-0.075	0.022	0.016
	(0.094)	(0.094)	(0.088)	(0.088)	(0.093)	(0.093)
D_1996	0.081	0.073	-0.020	-0.029	0.094	0.081
	(0.096)	(0.096)	(0.090)	(0.090)	(0.095)	(0.096)
D_1998	0.154	0.143	0.156	0.143	0.173	0.158
	(0.091)	(0.092)	(0.087)	(0.087)	(0.092)	(0.092)
D_2000	0.226	0.211	0.103	0.087	0.238	0.217
	(0.095)	(0.095)	(0.090)	(0.090)	(0.095)	(0.096)
D_2002	0.035	0.022	0.022	0.008	0.048	0.030
	(0.098)	(0.099)	(0.093)	(0.093)	(0.098)	(0.099)
D_2004	0.202	0.188	0.120	0.104	0.230	0.210
	(0.092)	(0.093)	(0.087)	(0.087)	(0.093)	(0.093)
Sector f.e.					X	X
R-squared	0.06	0.06	0.05	0.05	0.09	0.09
observations	766	766	766	766	766	766

Source: Author's calculations from the Health and Retirement Study, Current Population Survey, and Form 5500 data. Standard errors in parentheses.

Table VI
Effect of Risk-Sharing on the Variance in Assets for Whole Population Sample

	Variance in Log of Assets – Level Effect				Variance in Log of Assets – Elasticity			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
% DB Holders	-1.863	-1.841	-2.000	-2.158	-0.881	-0.865	-0.965	-1.027
(run together)	(0.241)	(0.252)	(0.308)	(0.329)	(0.091)	(0.096)	(0.115)	(0.123)
% DC Holders	-0.332	-1.314	-1.345	-1.553	-0.281	-0.635	-0.746	-0.779
(run together)	(0.383)	(0.460)	(0.415)	(0.473)	(0.145)	(0.175)	(0.156)	(0.177)
% Union Mem			1.109	1.271			0.634	0.694
			(0.485)	(0.496)			(0.182)	(0.186)
D_1994			0.134	0.138			0.077	0.077
			(0.171)	(0.171)			(0.064)	(0.064)
D_1996			0.409	0.418			0.135	0.136
			(0.172)	(0.173)			(0.065)	(0.065)
D_1998			0.600	0.612			0.293	0.294
			(0.173)	(0.174)			(0.065)	(0.065)
D_2000			0.736	0.755			0.355	0.356
			(0.177)	(0.179)			(0.066)	(0.067)
D_2002			0.930	0.949			0.346	0.348
			(0.176)	(0.178)			(0.066)	(0.067)
D_2004			0.913	0.931			0.401	0.403
			(0.174)	(0.176)			(0.065)	(0.066)
R-squared	0.04	0.04	0.07	0.06	0.06	0.06	0.09	0.09
observations	1,449	1,449	1,419	1,419	1,449	1,449	1,419	1,419

Source: Author's calculations from the Health and Retirement Study, Current Population Survey, and Form 5500 data. Standard errors in parentheses.

Table VII
Effect of Risk-Sharing on Variance in Assets: Comparing Elasticities for Whole Population

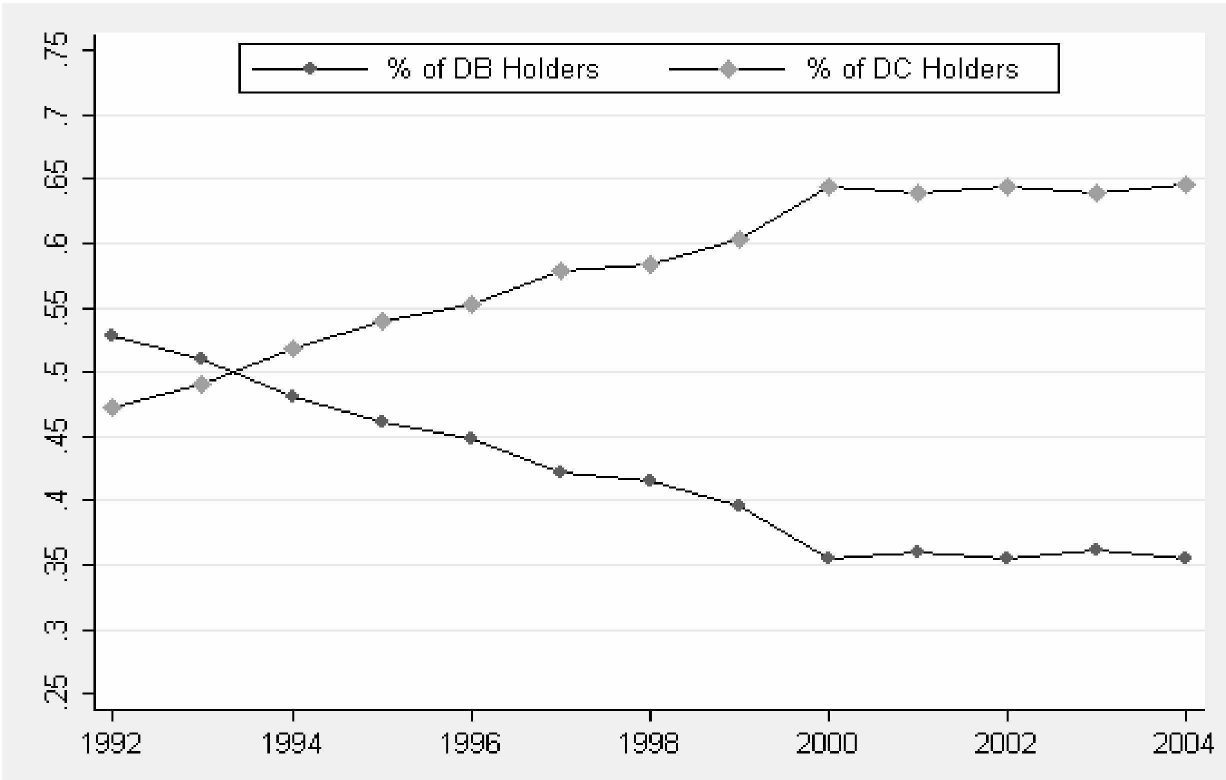
	Variance in Log of Assets – Elasticity		Variance in IHS of Assets – Elasticity		Variance in Log of Assets – Elasticity (w/ Sector f.e.)	
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	2SLS	OLS	2SLS	OLS	2SLS
% DB Holders (run together)	-0.965 (0.115)	-1.027 (0.123)	-0.535 (0.092)	-0.612 (0.098)	-1.277 (0.139)	-1.449 (0.154)
% DC Holders (run together)	-0.746 (0.156)	-0.779 (0.177)	-0.258 (0.124)	-0.393 (0.141)	-0.604 (0.173)	-0.591 (0.205)
% Union Mem	0.634 (0.182)	0.694 (0.186)	0.313 (0.144)	0.395 (0.148)	0.385 (0.201)	0.474 (0.205)
D_1994	0.077 (0.064)	0.077 (0.064)	0.080 (0.051)	0.082 (0.051)	0.069 (0.063)	0.067 (0.063)
D_1996	0.135 (0.065)	0.136 (0.065)	0.112 (0.051)	0.118 (0.052)	0.119 (0.064)	0.116 (0.064)
D_1998	0.293 (0.065)	0.294 (0.065)	0.270 (0.052)	0.278 (0.052)	0.268 (0.064)	0.263 (0.065)
D_2000	0.355 (0.066)	0.356 (0.067)	0.247 (0.053)	0.260 (0.053)	0.318 (0.066)	0.311 (0.067)
D_2002	0.346 (0.066)	0.348 (0.067)	0.259 (0.053)	0.271 (0.053)	0.309 (0.066)	0.302 (0.067)
D_2004	0.401 (0.065)	0.403 (0.066)	0.365 (0.052)	0.377 (0.053)	0.366 (0.065)	0.359 (0.066)
Sector f.e.					X	X
R-squared	0.09	0.09	0.07	0.07	0.12	0.12
observations	1,419	1,419	1,420	1,420	1,419	1,419

Source: Author's calculations from the Health and Retirement Study, Current Population Survey, and Form 5500 data. Standard errors in parentheses.

Table VIII
Alternative Specifications for the Estimation of the Effect of Risk-Sharing

alternative specification	How the Mean and Variance in Assets are Effected	How the Risk-Sharing Coefficients and Elasticities are Effected
Exclusion of Business Assets	Reduces both the mean and variance in assets	Reduces the magnitudes; no sign changes; no loss of statistical significance
Inclusion of Pension Wealth Imputations	Increases the mean and greatly reduces the variance in assets	Reduces the magnitudes; no sign changes; loss of statistical significance in most cases
Controlling for Mean Assets	(does not apply)	Slightly reduces the magnitudes; no sign changes; no loss of statistical signifcance

Figure I
Composition of Primary Pensions among Pension Holders



Source: Author's calculations of Form 5500 data.

Figure II
Composition of Primary Pensions among Pension Holders by Industry Sector

The sectors shown are agriculture, forestry, and fishing (1), mining and construction (2), non-durable manufacturing (3), durable manufacturing (4), transportation (5), wholesale (6), retail (7), finance, insurance, and real estate (8), business and repair services (9), personal services (10), entertainment and recreation (11), and professional and related services (12).

Source: Author's calculations of Form 5500 data.

Figure III

Risk-Sharing and the Variance in Assets: Pension Holders Sample

The upper portion shows the relationship on the percentage of defined-benefit holders; the lower portion is shown on defined-contribution holders. Source: Author's calculations from the Health and Retirement Study, Current Population Survey, and Form 5500 data.

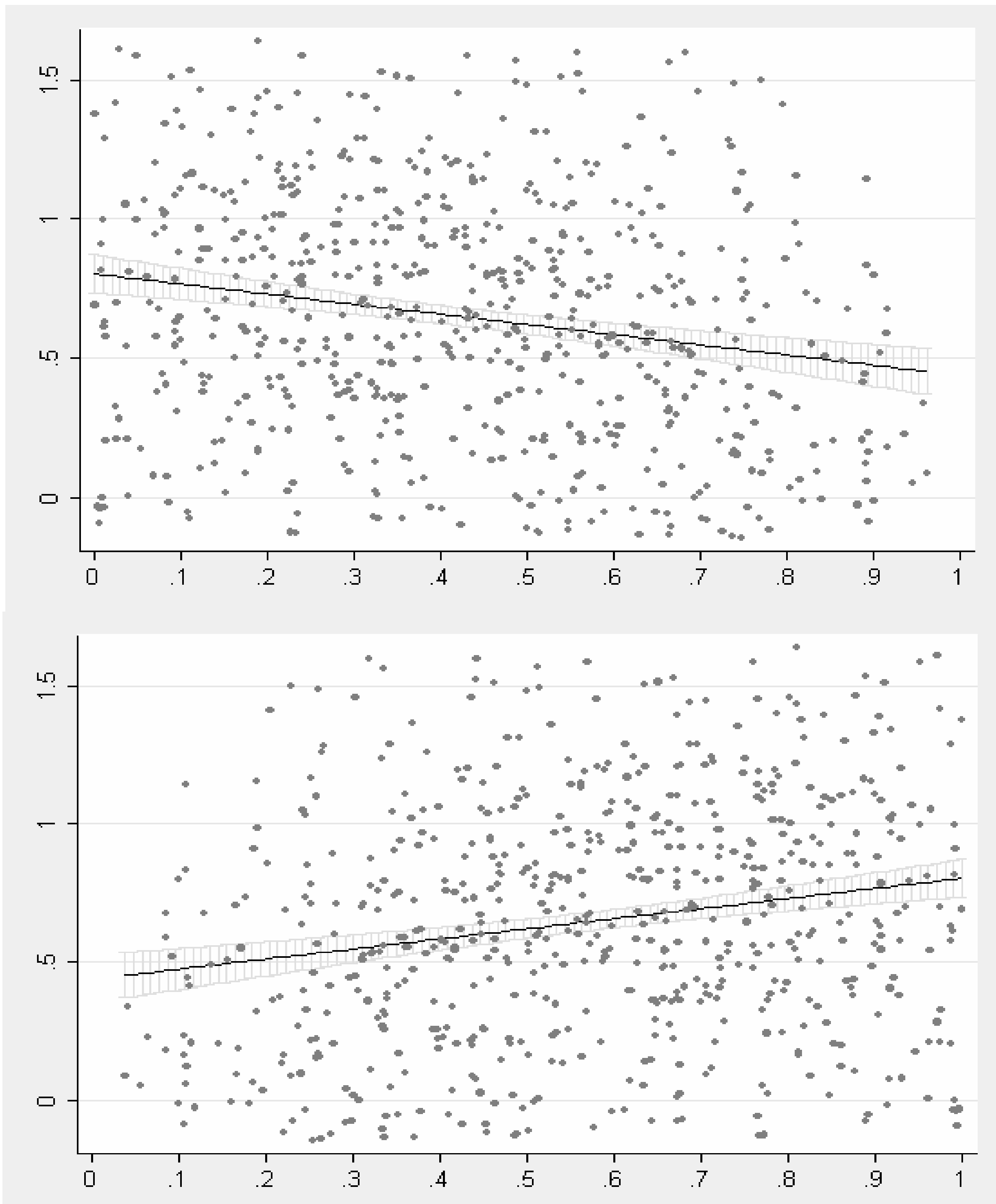


Figure IV
Risk-Sharing and the Variance in Assets: Whole Population Sample

The upper portion shows the relationship on the percentage of defined-benefit holders; the lower portion is shown on defined-contribution holders. Source: Author's calculations from the Health and Retirement Study, Current Population Survey, and Form 5500 data.