DEFINED CONTRIBUTION PLANS, DEFINED BENEFIT PLANS, AND THE ACCUMULATION OF RETIREMENT WEALTH

James Poterba
MIT and NBER

Joshua Rauh
University of Chicago Graduate School of Business and NBER

Steven Venti
Dartmouth College and NBER

David Wise
Harvard University Kennedy School of Government and NBER

August 15, 2007

ABSTRACT

The private pension structure in the United States, once dominated by defined benefit (DB) plans, is currently divided between defined contribution (DC) and DB plans. Wealth accumulation in DC plans depends on the participant's contribution behavior and on financial market returns, while accumulation in DB plans is sensitive to a participant's labor market experience and to plan parameters. This paper simulates the distribution of retirement wealth under representative DB and DC plans. It uses data from the Health and Retirement Study (HRS) to explore how asset returns, earnings histories, and retirement plan characteristics contribute to the variation in retirement wealth outcomes. We simulate DC plan accumulation by randomly assigning individuals a share of wages that they and their employer contribute to the plan. We consider several possible asset allocation strategies, with asset returns drawn from the historical return distribution. Our DB plan simulations draw earnings histories from the HRS, and randomly assign each individual a pension plan drawn from a sample of large private and public defined benefit plans. The simulations yield distributions of both DC and DB wealth at retirement. Average retirement wealth accruals under current DC plans exceed average accruals under private sector DB plans, although DC plans are also more likely to generate very low retirement wealth outcomes. The comparison of current DC plans with more generous public sector DB plans is less definitive, because public sector DB plans are more generous on average than their private sector counterparts.

We are extremely grateful to Tonja Bowen for extraordinary and tireless research assistance, to Sue Lin for assistance with our simulation algorithm, to Gary Engelhardt and Anil Kumar for graciously providing us with tabulations from their HRS Defined Contribution Plan imputation algorithm, to Paul Bingley, Peter Diamond, Gary Engelhardt, Jon Gruber, Helena Stolyarova, and many seminar participants for helpful comments, and to the National Institute of Aging for research support.

Private retirement arrangements in the United States were once predominantly defined benefit (DB) pension plans. In the last two decades, however, there has been a shift toward defined contribution (DC) arrangements. Very few firms have created new DB plans and many firms have moved toward greater reliance on DC plans, particularly for new workers. Many rapidly expanding industries have relied on DC rather than DB plans to provide for employee retirement. Buessing and Soto's (2006) analysis of data from Department of Labor Form 5500 filings shows that the number of individuals who participate only in a private sector DB plan has declined from 9.6 million in 1990 to 6.6 million in 2003. The number of individuals covered by both a DB and a DC plan has been roughly constant at nearly 14 million. The number of private sector employees with only DC coverage has risen from 11.5 million in 1990 to 30.1 million in 2003. These trends are likely to emerge in more recent data as well. Munnell and Soto (2007) explain that many firms have "frozen" DB plans since 2003.

Workers covered by DB plans are increasingly concentrated in the public sector. The U.S. Census Bureau (2006) reports 2,659 federal, state, and local pension systems in the U.S., covering 17.9 million workers. Although the Census Bureau does not collect detailed data on plan type, a Pensions and Investments survey in 2004 shows that 224 of the 1000 largest pension plans were public sector plans, with DB assets representing 89.3 percent of all public sector pension assets. Among public sector plans, 62 percent have no DC assets, while for 89 percent DC assets are less than one fifth of combined DB and DC assets. The first Pensions and Investments survey in 1997 yields almost identical statistics.

The growth of private sector DC plans has given employees new responsibility for managing retirement assets and made retirement wealth accumulation a function of an employee's contribution and asset allocation decisions. Accrued benefits in DB plans do not depend on financial market returns, except in extreme circumstances such as plan insolvency. Benefits in DC plans, however, are a function of financial market returns. Some analysts have suggested that DC plans expose prospective retirees to greater risk than DB plans because of this link.

Several recent studies have examined financial market risk in DC plans and the role of asset allocation choices in controlling this risk. Shiller (2005) studies a variety of asset allocation rules in the context of a private accounts Social Security system – essentially a mandatory DC system. Poterba, Rauh, Venti, and Wise (hereafter PRVW) (forthcoming) examine how age-related adjustments in asset allocation, such as those associated with lifecycle mutual funds, affect the distribution of DC plan balances at retirement. Net-of-expense asset returns over the course of a DC plan participant's working life, asset allocation, and the participant's contribution rate are key determinants of these balances.

Although accumulations in DC plans are risky, they are not necessarily riskier than accumulations in DB plans. While many researchers have recognized that DB plan accumulations plans are uncertain from the participant's perspective, few have tried to compare the risks of DB and DC plans. Four previous studies are particularly noteworthy. Balcer and Sahin (1979) compare DB and DC plans in a lifecycle setting, recognizing that earnings uncertainty and job transitions have an important effect on the accumulated wealth of DB plan participants. Bodie, Marcus, and Merton (1988) note that DB and DC plans both entail risks, but that these risks are different. Neither of these studies make quantitative estimates of relative risks; two more recent studies do. Samwick and Skinner (2004) use data from the 1983 and 1989 Survey of Consumer Finances and the associated Pension Provider Supplement (PPS) to summarize DC and DB plan attributes. They generate synthetic earnings histories under the assumption that the logarithm of earnings follows a random walk with age-related drift, and they evaluate DB and DC wealth accumulation for these earnings histories. This approach may miss subtle stochastic properties of actual earnings histories. The results suggest that for many workers DC plan accumulations are likely to exceed the actuarial present discounted value (PDV) of DB plan benefits. Finally, Schrager (2005) uses data on earnings and job change patterns from the Panel Survey of Income Dynamics to study related issues. She finds that job turnover increased in the 1990s, making DC plans more attractive relative to DB plans for many workers. Both of the empirical studies parameterize the earnings and job change processes, thereby suppressing some of the richness in individual earnings histories.

One of the key risks in both DB and DC wealth accumulation is an ex ante risk that workers face when they accept a job: what does the firm's DC or DB plan offer? There is substantial variation in the generosity of employer matching contributions in DC plans, and in the normal retirement age and level of post-retirement benefits in DB plans. In addition to these ex ante risks, workers also face ex post risks that are realized as their working career unfolds. These include their earnings path, which is a key input directly to DB wealth accruals and which affects the capacity to make DC contributions, the economic fortunes of their employer, which may lead to changes in the retirement plan parameters, their job tenure and the number of jobs they hold over their working career, the choices they make in a DC plan, and the financial market returns that they earn on their DC plan investments. Some components of both the ex ante and ex post risk are under the control of the worker, who may decide whether or not to work for a firm with particular pension characteristics, whether or not to voluntarily separate from a firm with a DB plan, or whether or not to contribute the maximum amount to a DC plan.

This paper draws on lifetime earnings histories from the Health and Retirement Study (HRS) to summarize the variation in DB and DC plan accumulations at retirement. Our analysis summarizes the total variation in such accumulations, combining both ex ante and ex post risk components. The HRS data enables us to capture individual-level heterogeneity in age-earnings profiles and in job transitions. We employ historical asset return distributions to simulate the distribution of financial outcomes for DC plan participants with various asset allocation patterns, and the HRS DB Pension Calculator to simulate post-retirement benefits under a sample of large DB plans.

The paper is divided into six sections. The first describes our sub-sample of HRS households. It also describes the DC plans that these households participate in, with particular attention to the share of salary that employers and employees contribute to the plan. Section two describes our algorithm for simulating the distribution of DC retirement plan assets. It draws substantially on PRVW (2005, forthcoming). Section three describes our algorithm for computing DB plan accumulations and explains how we impute job transitions to HRS respondents. The fourth section presents our estimate of the distribution of DC and DB plan accumulations for a sample of representative plans. Section five discusses the broader issue of the risk measurement for DB and DC plans, and it identifies a number of factors that we have not modeled that might contribute to variation in retirement wealth outcomes. There is a brief conclusion.

1. Selecting a Sample of HRS Households for Analyzing DC and DB Plan Risks

We use individual earning histories for HRS respondents along with data on DB and DC plans in the 1990s to evaluate pension wealth accumulation. Actual earnings histories preserve elements of labor market experience that are lost with simpler earnings processes. We focus on married couples both because seventy percent of the individuals in the pre-retirement cohort are married and to avoid the heterogeneity that arises in the single population. Never married individuals typically have very different financial circumstances than widows and widowers. We further restrict our sample to ensure the presence of usable data for several key data items.

Table 1 summarizes the impact of our sample selection criteria. There are 3,833 HRS households with Social Security earnings histories. Haider and Solon (2000) explore the selection properties of the HRS sub-sample with earnings histories, and find that it is relatively representative of the broader HRS sample. Our sub-sample consists of couples headed by men aged 63-72 in 2000. Restricting to couples eliminates approximately 44 percent of the sample, and the age restriction removes an additional 19 percent. The resulting sub-sample includes 1,400 households. We exclude those younger than 62 because including them would require extrapolating earnings histories for the latter part of the working career. Including those over 73 would make it difficult to calibrate financial circumstances at retirement age. We focus on the earnings and pension benefits for the husband in each married couple because husbands in our sample have fewer earnings interruptions than their wives.

1.1 Earnings Histories

The HRS earnings records, which begin in 1951, consist of different earnings measures in different years. Between 1951 and 1991, the HRS includes Social Security earnings records for a subset of respondents. The data records include earnings if earnings are below the Social Security payroll tax threshold, but simply include the threshold value for those with earnings above it. After 1991, the HRS includes self-reported total earnings for each member of each HRS household. For the years between 1980 and 1990, W-2 earnings records from the Internal Revenue Service have been linked to HRS survey records. While W-2 filings exclude labor income from self-employment, they are not top-coded.

The taxable maximum earnings level for Social Security has varied over time, and so has the dispersion of earnings, so the fraction of households with top-coded earnings varies from year to year. For high-income workers such as those with a college education, the earnings cap is a substantial impediment to measuring lifetime contributions to a DC plan or the earnings that may generate DB payouts. In PRVW (2006), we report the fraction of our sample participants in various educational attainment categories who report top-coded earnings in each year between 1951 and 1979. The data show that in some years in the early 1970s, more than three quarters of college-educated HRS respondents had top-coded earnings. The real value of the threshold varied over time and occasionally experienced sharp changes. In 1971, the top-coded fraction peaked at 79.8 percent for college-educated respondents, 65.3 percent for those with a high school education or some college, and 41 percent for those with less than a high school degree. The overall top-coded fraction was 61.9 percent in 1971. It declined to 42.5 percent in 1974, and reached 31.1 percent in 1979. Prior to 1960, less than one quarter of the HRS sample had top-coded earnings.

Top-coded earnings data lead to downward biases in both estimated DC plan accumulations and projected DB benefits for high earners. To remedy this problem, we replace top-coded earnings amounts with an estimate of the respondent's conditional mean earnings, conditional on earnings above the top-code. We estimate cross-sectional tobit equations for each year prior to 1980 using the reported Social Security earnings for men in our sample, with individual characteristics such as age and education as explanatory variables. The estimated tobit coefficients depend on the estimation sub-sample in the years when a substantial fraction of individuals are affected by the top-code. The results are more robust when respondents with very low earnings, for example those below \$2500 in \$2000, are excluded from our sample. We therefore fit our tobit models only to those respondents whose earnings exceed this level.

Figures 1a through 1c summarize our top-coding corrected mean age-earnings profiles for those with less than a high school education, those with high school and some college, and those with college and beyond. The median earnings path in Figure 1b shows an unusual "bump" in early middle age. This appears to be due to the top-coding adjustment for years in which an especially high fraction of workers had reported earnings above the tax cap. This unusual pattern does not appear at the 25th or 75th percentiles, probably because there is less variation over time in the fraction of workers affected by the tax cap at these percentiles than at the median. Our algorithm for correcting top-coding does not exploit the intertemporal dependence of earnings, as the procedure in Scholz, Seshadri, and Khitatrakun (2006) does. It avoids extrapolating the serial correlation structure of earnings in mid-life to other age ranges at the cost of ignoring the persistence of earnings for a given individual through time.

1.2 Adjusting Wage Histories for Pension Accruals

The structure of retirement benefits, whether DB or DC, at a firm may have an important effect on an individual's reported earnings. If a worker is employed at a firm with a generous DB pension plan, we would expect him to earn less in wages than a comparably-productive worker employed at a firm with no pension or a less generous plan. If we compute DB and DC wealth accruals for HRS households using their reported earnings histories, then we are effectively assuming that a firm's pension plan does not affect its workers' wages. This is inconsistent with competitive firms offering a total compensation package, wages plus benefits, with a present value equal to the present value of the worker's marginal revenue product.

"Correcting" for the potential relationship between pension generosity and earnings history could be done in various ways. One could assume that in the absence of the worker's current DC or DB plan, earnings would have been higher by the amount of the employer's DC plan contribution, or by the amount of the DB plan accrual for a given year. Leaving aside the problem of measuring DB accruals, this raises the question – studied for example by Gruber (1994) – of whether firms equalize total compensation costs and marginal revenue products on a worker-by-worker basis, or for broad groups of workers.

Rather than making person-specific corrections, we adjust the earnings history for everyone covered by a DC plan by the <u>average</u> employer contribution share to DC plans. If we denote this average by c, we multiply the earnings of all DC plan participants by (1+c) to obtain their earnings in a setting with no DC plan. For participants in DB plans, we compute the PDV of DB benefits at retirement, B, as well as the PDV of wage payments, W. At retirement, B discounts future payments, while W cumulates past earnings. We average the ratio of B/W over all DB participants, denote this average b, and then multiply earnings for all DB participants by a factor (1+b) to estimate their earnings in the absence of a DB pension plan. This adjustment, along with the adjustment for DC plan participants, yields a measure of "pension free earnings" (PFE) for all households in our sample.

To estimate DB wealth at retirement, we calculate PFE/(1+b) and use the resulting earnings history as the input to the HRS Pension Estimation Program. In this case, the earnings history for a household with a DB plan will be the reported earnings history, since we have multiplied and divided by (1+b) factors. For DC plan participants, however, the earnings history that we use is the actual earnings history multiplied by (1+c)/(1+b). In a similar fashion, we divide PFE by (1+c) when we calculate earnings for the purpose of DC plan contributions. We are therefore using reported HRS earnings for all DC plan participants, but an adjusted earnings history measure, PFE*(1+b)/(1+c), for those in DB plans. We report results below both for unadjusted and "pension adjusted" wage histories.

1.3 Retiree Wealth for HRS Households

PRVW (2006) summarize the value of DC and DB wealth in various survey years for households in our sub-sample, along with information on non-pension wealth. The pension wealth imputations provided by version 1.0 of the HRS pension wealth calculator, described by Peticolas and Stolyarova (2003), are of interest in their own right. Gustman, Mitchell, Samwick, and Steinmeier (2000) and Rohwedder (2003) discuss the measurement of pension wealth in household data, with particular discussion of the HRS. Cunningham, Engelhardt, and Kumar (hereafter CEK) (forthcoming) develop an improved algorithm for imputing wealth to DC plan participants. We build on several of their suggestions, although we do not employ their DC wealth estimates.

For DC plan balances, the HRS includes a self-reported balance. Although Gustman and Steinmeier (2004) show that self-reported data are more prone to measurement error than are data from providers, we rely on this information. The HRS collects data every other year. We use the balance at age 63 or 64 for those who are this age in 2000, and we adjust the plan balances for those who are older and younger in 2000 by imputing a rate of return to DC assets. For HRS respondents who are 63 or 64 in one of the survey years, and who are covered by a DB plan, we use the HRS Pension Calculator to compute DB wealth – the present discounted value (PDV) of future DB benefits -- for a retirement age of 62. We then “age” this PDV by one year, to age 63, using a three percent real interest rate – the assumption in the SSA’s intermediate scenario. For Social Security wealth (SSW), we use cohort mortality tables and the SSA intermediate-cost scenario discount rates to calculate the PDV of current or projected Social Security benefits when the husband is aged 63 or 64. We normalize the value of the wife’s Social Security to be the value when the husband is aged 63-64, assuming that Social Security payments start for the wife at age 62 if they have not started already. We value Social Security as a joint survivor annuity.

Table 2 shows mean, median, and various percentiles of the wealth distribution for the households in our sample. We report pension wealth as well as non-pension wealth calculated along the lines described in PRVW (forthcoming). The mean total wealth for those in our sample, shown in the last horizontal panel, is \$783,400. The median is much lower -- \$536,000. The tabulations show that there are substantial differences in wealth accumulation across households both within and across education categories. Although median household net wealth is not the sum of the medians of the constituent parts, we can offer some insights on the wealth distribution from the summary statistics in Table 2. For the group with less than a high school education, the PDV of Social Security benefits represents roughly half of household net worth, with net housing equity and other wealth in durables and related items accounting for nearly one fifth. On average, current DB and DC wealth values account for less than one tenth of household net worth for this group. The DB wealth in this table, however, includes only the PDV of expected benefits from the current job: it does not include expected benefits from past jobs or benefits received by those already retired. For those in the college educated group, the PDV of Social Security benefits accounts for less than a quarter of net worth, and other financial assets are the single most important component of net worth. DC wealth is substantially more important than DB wealth on average, with the mean DC accumulation, \$330,900, roughly five times greater than mean DB wealth.

The third panel of Table 2 shows that for the household at the median of the wealth distribution, net worth including Social Security wealth equals $536,800. Nearly half of this amount takes the form of the PDV of expected Social Security payments and another twenty percent is accounted for by housing equity. The role of housing and Social Security wealth declines at higher percentiles of the wealth distribution while other financial wealth becomes more significant. There is greater disparity in "other financial wealth" than in any other component of the household balance sheet. This wealth component is negligible at the 20th percentile of the distribution, but by the 80th percentile its value is $215,200. The value of Social Security and annuity wealth varies least across percentiles of the distribution.

The results in the table show the substantial dispersion of both DC and DB plan accumulations for current retirement-age households. For more than half of all sample participants, DB pension wealth is zero. At the 80th percentile, individuals with high school and some college have $12,000 in DB wealth and individuals with college or postgraduate degrees have DB wealth of $65,100. Mean DB wealth accumulation is $47,700. More than sixty percent of the sample reports some value in a DC plan, but the median value is only $22,700 even though the sample mean is $136,400. This reflects a highly skewed distribution of account balances, which has been noted in other studies of DC wealth accumulation such as Munnell and Sunden (2004). It is difficult to compare the dispersion in DC plan balances in the HRS sample with the distribution that emerges from our simulations, because the current retirees have typically participated in a DC plan, such as a 401(k) plan, for a fraction of their career. Our simulation results explore the consequences of career-long participation.

The net worth of households in our HRS sub-sample is greater than that of the entire HRS population. Net worth of HRS households has also increased over time as the survey has progressed. These factors explain why our net worth measures exceed those in some earlier studies, such as Moore and Mitchell (2000), who focus on all HRS households and find mean net worth in 1992 of $478,313.

2. Wealth Accumulation in DC Plans

We now compute DC and DB plan accruals for households under the assumption that each one faces only one type of pension plan throughout its working career. In practice employees may experience shifts from employers with one type of plan to employers with another, but the presence of strong industry patterns in pension arrangements provides some support for our approach.

We model DC plan accumulation by simulating the path of plan contributions and investment returns over an individual's working life. We use either actual lifetime earnings trajectories, or earnings trajectories modified to remove the influence of pension accruals, along with the historical distribution of returns on financial assets and realistic assumptions about the expenses charged by financial institutions that manage assets in defined contribution retirement plans to calculate DC balances at age 63..

2.1 Contributor Behavior

We assume that an individual contributes a fixed percentage of his earnings to a DC plan each year during a working life that begins at age 28. The contribution rate is drawn from the empirical distribution of combined employer and employee contributions as a percentage of pay for HRS males with positive DC contributions. Table 3 shows the distribution of contributions as a share of earnings using the methodology described in CEK (forthcoming). Employee contributions are derived from W-2 filings that are linked to HRS records and employer contributions are from pension plan rules contained in employer-provided Summary Plan Descriptions (SPD). The mean employee and employer combined contribution rate is 8.3 percent of earnings. This estimate is lower than the estimate of 9.8 percent obtained from the 1993 Current Population Survey by Poterba, Venti, and Wise (1998a) and lower than the estimate of 9.7 percent obtained by Holden and VanDerhei (2001) using the EBRI-ICI sample of firms. Poterba, Venti, and Wise (2007) find that the median contribution in the 2003 Survey of Income and Program Participation is 9.8 percent. The 8.3 estimate that we use here is comprised of a mean employee rate of 6.6 percent and a mean employer rate of 1.7 percent. The latter estimate appears too low – Form 5500 filings show that the employer rate should be about one-half of the employee rate. We suspect this discrepancy is peculiar to the relatively small sample of SPDs used in our analysis. Our reported DC balances are thus likely to be understated by as much as 1.5 percent. Rather than using administrative data we could rely on self-reported contributor behavior. However CEK (forthcoming) show that self-reports are a noisy measure of actual contributions.

The mean of the contribution rate distribution is 8.3 percent, but there is substantial dispersion. The 25th percentile value of the contribution rate is less than 5.3 percent, the median is approximately 7.7 percent, and the 75th percentile value is greater than 10 percent. Ten percent of the individuals in DC plans have combined employer and employee contribution rates of at least 15 percent of salary, and ten percent have contribution rates of no more than three percent. We assume that each individual in our sample participates in the DC plan in every year for which he has Social Security earnings until age 63. Contributions are set to zero when the household is unemployed, retired, or over the age of 63.

We denote each individual's DC contribution at age a by $C_i(a) = c_i*E_i(a)$, for $E_i(a)$ the earnings of individual i at age a and c_i the combined share of earnings contributed by the employer and employee. We express this contribution in year 2000 dollars. We assume that contributions as a share of earnings are constant for each individual at all jobs that he holds. This amounts to assuming the unlikely counterfactual that when an individual changes jobs, he finds another employer with the same combined employer and employee contribution rate to the 401(k) as at the previous employer. The other assumption that we could use in our simulations, that each job has a contribution fraction which is drawn from the distribution of contribution rates when an individual starts it, would eliminate any persistence in contribution fractions for a given individual from one job to the next. This also seems like an improbable counterfactual. Our assumption of a single contribution rate for the entire working career will result in a larger dispersion of retirement wealth outcomes than the alternative assumption, since randomization in contribution rates within the lifetime will move all workers toward average contribution rates.

To find the DC balance for an individual at age 63 (a = 63), we cumulate contributions over the course of the working life with appropriate allowance for asset returns. Let $R_i(a)$ denote the net-of-expense return earned on DC assets that were held at the beginning of the year when the participant attained age a. The value of the individual's DC assets at age 63 is then given by:

(1) $$W_i(63) = \sum_{t=0}^{35} \left\{ \prod_{j=0}^{t} [1 + R_i(63 - j)] \right\} C_i(63 - t)$$

$R_i(a)$ depends on the year-specific returns on stocks and bonds, and on the mix of stocks and bonds that the individual owned at age a.

2.2 Asset Allocation and Rate of Return Assumptions

We assume that the three primary assets that individuals hold in their DC plans are mutual funds that invest in corporate stock, nominal long-term government bonds, and inflation-indexed long-term bonds (TIPS). We do not address the possibility of poorly diversified portfolios or holdings of company stock. We assume that the distribution of returns on each of these asset classes is given by Ibbotson Associates' (2004) empirical distribution of returns during the 1926 to 2003 period. The average annual arithmetic real return on large capitalization U.S. equities during this period was 9.2 percent, with an annual standard deviation of 20.5 percent. Real returns on long-term U.S. government bonds averaged 2.8 percent with a standard deviation of 10.5 percent.

We assume that TIPS offer a certain real return of 2 percent per year, approximately the current TIPS yield. Index bonds deliver a net-of-inflation certain return only if the investor holds the bonds to maturity, and selling the bonds before maturity exposes the investors to asset price risk. We nevertheless treat these bonds as riskless long-term investment vehicles. We draw returns from the stock and bond return distributions for a given "year" in our simulations, thereby preserving the historical contemporaneous correlation structure between stock and bond returns.

We assume a 32 basis point expense ratio on equity mutual funds, the weighted mean expense ratio on S&P 500 index funds reported in Hortaçsu and Syverson (2004), and use the same expense ratio for government bond funds. We assume a 40 basis expense ratio for funds invested in TIPS.

Campbell (2001) and others argue that the period covered by our data sample was particularly favorable for equity markets and caution against extrapolating these returns to the future. To allow for such a possibility, we perform some simulations in which all equity returns are reduced by 300 basis points relative to their level in the actual historical distribution.

Each time we simulate a DC plan balance at age 63, we draw a sequence of 35 real stock and bond returns from the empirical return distribution. The draws are done with replacement and we assume that there is no serial correlation in returns. We then use this return sequence to calculate the real value of each individual's DC plan balance at age 63 under the different asset allocation strategies. For each of the 1,400 workers in our sample, we simulate the DC balance at age 63 50,000 times, thereby obtaining a distribution of wealth values at retirement. We present information on the mean and various percentiles of this distribution. We consider our full sample as well as sub-samples defined by education levels.

We simulate seven different asset allocation strategies for each individual's DC account. The first three involve investing in only one asset: (i) TIPS; (ii) long-term government bonds, and (iii) corporate stock. Portfolio (iv) is an age-invariant 50-50 mix of stocks and TIPS, while portfolio (v) is a 50-50 mix of stocks and nominal government bonds. Portfolios (vi) and (vii) are lifecycle portfolios that combine stocks and TIPS, and stocks and nominal bonds. Marquez (2005) reports that 38 percent of all 401(k) plans offer lifecycle funds. The lifecycle funds offered at different fund families follow different age-phased asset allocation rules. PRVW (forthcoming) describe these funds in detail and report summary information on the investment patterns of several large lifecycle funds. We assign age-specific equity exposure rates equal to the average age-specific allocations in the set of lifecycle funds studied in PRVW (forthcoming), and assume a 74 basis point expense ratio for investing in the lifecycle products.

In our baseline simulations we constrain all households to follow the same asset allocation strategy. This illustrates how much variation in retirement wealth will emerge from the cross-sectional differences in earnings histories and contribution rates, and from the ex post variation in rates of return over the course of a working career. This reduces the cross-sectional variation in DC balances at retirement relative to the distribution that would obtain if 401(k) participants followed different asset allocation strategies. To gauge the sensitivity of our findings to this assumption, we also ran some simulations in which we randomly assigned asset allocation strategies to each participant. In this case there is an additional step in our simulation procedure. Along with a lifetime 401(k) contribution rate, each worker is assigned an asset allocation rule. We then calculate the individual's DC plan balance at retirement under these assumptions.

3. Wealth Accumulation in DB Plans

For each respondent who is covered by a DB plan, the HRS includes a detailed pension plan summary in a supplementary file of Summary Plan Documents. The Pension Estimation Program (PEP) codifies the plan attributes and makes it possible to estimate each HRS respondent's prospective DB pension payouts. This program can also be used to compute hypothetical DB plan accruals for individuals who are not actually covered by a DB plan. The PEP includes coding for the pension Summary Plan Documents collected from employers in 1993 and 1999. These correspond to plan years 1992 and 1998 respectively. The DB plan accumulations reported in Table 2 are based on PEP output.

We use the PEP to estimate the PDV of DB pension wealth for all households in our sample, randomly matching them to a DB plan for each of their jobs. The inputs to the PEP are an earnings history, a retirement or termination date, and a pension plan. The output is a stream of retirement income payouts. With information on mortality rates and discount factors, these payouts can be used to estimate the expected PDV of future DB payouts, which equals accrued DB wealth. By performing such calculations with different DB plans, we can illustrate the variation in DB pension wealth associated with cross-sectional differences in these plans. The variation in payouts across workers under a given plan illustrates the variation in DB payouts associated with different earnings histories. The observed variation in DB pension accruals reflects both earnings history variation and plan variation. Our algorithm does not address the possible matching of individuals who expect to have particularly stable, or unstable, employment trajectories to particular types of pension plans. Allowing for such correlation might reduce the cross-sectional variation of simulated DB balances because those who are less likely to change jobs would be more likely to accept employment at firms with DB plans. Such matching would reduce the incidence of turnover-related reductions in DB plan benefits.

To analyze each household's DB accruals, we divide each individual's earnings history into employment spells at various employers. The data requirements for such a separation are greater than those associated with measuring the stream of potential contributions to a DC plan, where we assumed that all earnings contributed to DC plan accumulation. We also need to select a sample of DB plans that we will consider in matching workers to plans.

3.1 Job Histories for HRS Respondents

We construct job histories for each HRS respondent based on both his earnings history between ages 28 and 63 and his responses to various HRS questions about job tenure. The survey includes questions about the number of years the respondent has worked at his current or longest-tenure job. Unfortunately, many responses are inconsistent across HRS waves, and the resulting job histories match poorly with reported earnings histories. We therefore do not rely exclusively on the self-reported job tenure information, but instead combine information from these questions with data from earnings histories. We infer the beginning and the end of a job from an HRS earnings history by assuming that years without earnings reflect job interruptions. Furthermore, as in our top coding corrections, observations with less than $2500 in (year 2000) earnings are defined as a work interruption. This may cause us to underestimate the length of some jobs that involved layoff or temporarily reduced workloads. Finally, given the typical characteristics of our sample DB plans, we assume that a job did not generate any DB pension benefits unless it lasted for at least five years. An individual's earnings for a given year therefore yield a DB benefit accrual only if the individual is between ages 28 and 63, the earnings amount is greater than $2500, and the years is one of a string of at least five consecutive years of earnings exceeding $2500. We assume that no one in our sample has more than three DB-eligible jobs during his work career. In practice, very few individuals report DB pension benefits from more than three jobs.

Among the 1400 individuals in our sample, 77.2 percent (1081) are assigned a single DB-eligible job during their lifetimes, while 18.4 percent are assigned to two such jobs. The remaining 3.4 percent of the sample is divided equally between those who have no job that lasts more than five years and those who have three jobs. PRVW (2006) disaggregate this information by educational attainment, and find relatively similar patterns for those with different educational backgrounds.

Table 4 reports the distribution of job lengths in our sample. Our unit of observation is a job, not an individual, so when we report that the median job for a person with less than a high school education lasted 25 years, this is the median of the 286*1 + 65*2 + 9*3 = 443 <u>jobs</u> that we observe for individuals in this education category, not the median for the 286+65+9 = 360 <u>individuals</u> in this education category.

Most jobs are long-lasting. The 25th percentile value for job length for all three education sub-samples is either 11 or 12 years, and the median job length is between 24 and 27 years. One quarter of all jobs last at least 33 years. These data indicate that a substantial subgroup of workers reaching retirement age in the 1990s had long-term jobs that could support substantial DB plan accumulation. Another significant subgroup of workers, however, worked at several different jobs, and would have been unlikely to accumulate substantial DB pension wealth.

3.2 Sampling DB Plans

Our sample of DB plans consists of the 25 largest public-sector and 25 largest private-sector DB plans, ranked by the number of HRS participants covered by the plan in 1998. All of the plans are associated with large employers. In most cases the private sector employers are large national firms. The public sector pension plans are often connected with state-managed programs for public sector employees; in some cases employees in many localities are covered by the same state-wide pension plan.

Confidentiality issues preclude reporting of individual DB plan attributes. The plans in our sample, however, display many diverse provisions. This suggests that any analysis of DB and DC plan risk that is based on only a stylized example of a DB plan is likely to understate the variation in DB plan accruals. Virtually all of the private sector plans we consider use five-year cliff vesting, and most use age 65 as a normal retirement age. There is substantial divergence, however, in the early retirement provisions of different plans, and in the earnings measure that is used to determine benefits. Social Security integration provisions also vary, with 11 of the 25 private-sector plans offering no integration and the remaining 14 choosing a variety of integration strategies.

There are also some similarities and some differences across public sector plans. The patterns are different, however, from those for private-sector plans. There is more variation in vesting rules and in normal retirement ages across public sector plans than across private sector plans. Public sector plans typically provide benefits based on a measure of highest average earnings over a several-year interval. Almost all – 23 – are integrated with Social Security. There is substantial heterogeneity among public sector plans, as among private sector plans, with regard to early retirement provisions.

We focus on the standard provisions of each DB plan, not on special "window" provisions that are sometimes used to encourage early retirement or retirement more generally. The sporadic use of such provisions makes actual DB accruals even more variable than our results suggest.

3.3 Calculating the PDV of DB Wealth

Our simulations assign an individual with a given employment history to a particular DB plan, and calculate the resulting PDV of DB accruals. We assume a five percent nominal discount rate, a two percent real discount rate, and a real wage growth rate of one percent per year. For plans that are integrated with Social Security, we assume the historical growth rate of Social Security benefits for past years and a zero real benefit growth rate prospectively. We specify that benefits are taken in the form of a 50 percent joint-and-survivor annuity, given that the sample comprises married men, and we use the PEP to estimate the PDV of DB benefits assuming a retirement at 63. We assume that DB plan participants live until at least age 63, thereby suppressing the risk of early death.

To transform the distribution of accumulated DB wealth under different DB plans into an expected PDV of DB wealth, we average the outcomes of various simulation runs. We construct separate averages for public sector and private sector plans. In our simulations, when an individual takes a job at a firm with a DB plan, we draw a DB plan at random from the 25 public sector or 25 private sector plans in our sample. Although in our DC plan analysis we assumed a single lifetime contribution rate, in the DB setting we repeat the randomization across plans for each job in the individual's career. An individual with three jobs would therefore face 25^3 possible combinations of public sector DB plans and the same number of possible private sector combinations. We assume that an individual who works in one sector is restricted to remain in that sector throughout his working life.

4. The Distribution of DC and DB Wealth at Retirement

We report our findings for DC plan balance at age 63 under a range of different asset allocation and asset return assumptions, and then turn to comparable findings for DB plans.

4.1 DC Plan Balances at Retirement

Table 5 shows our simulated distribution of DC plan balances in year 2000 dollars. The simulations in the left panel use the historical distribution of returns, while those in the right panel use modified returns in which the average yield on equities is 300 basis points below its historical average. Individuals are stratified by education group within each panel. The table reports the mean wealth at retirement for each asset allocation strategy, as well as four points in the distribution of returns. We focus our discussion of dispersion of DC wealth accumulation and the effects of different asset allocation strategies by emphasizing our findings for a single education group, the group with a high school degree but not a college degree. Relative rankings of different strategies are similar for other education groups.

The first rows in Table 5 show the wealth at retirement associated with the TIPS-only strategy. This strategy has riskless investment returns but since contribution rates are drawn from a distribution and earnings trajectories vary across households, there is still cross-sectional variation in DC accumulations. Conditional on an individual's earnings trajectory and the combined employer and employee contribution rate, however, there is no asset return risk. The mean DC balance for individuals with high school and/or some college, $177,000, provides a useful benchmark for the discussion that follows. The variation in DC plan contribution rates yield first, tenth, and ninetieth percentile outcomes of $39,100, $58,600 and $325,500, respectively.

The second panel shows that holding only government bonds leads to a higher average DC balance at retirement, $213,400, than holding only TIPS. This is due to the higher average real return on nominal bonds. The average DC plan balance at 63 is over twenty percent greater than the value with TIPS, while the median is less than ten percent greater. There is also more dispersion in DC plan balances with nominal government bonds than with TIPS because there is now variation due to the returns earned on DC contributions. The first percentile outcome is $26,100 with nominal bonds ($39,100 for TIPS) and the 90th percentile is $410,900 ($325,500).

When the DC plan balance is invested completely in corporate stock, the average DC balance at retirement is much higher than that with either TIPS or nominal government bonds: $918,900. Because the mean return on stocks is so much higher than that on either nominal or inflation-indexed bonds, even the outcomes in relatively low quantiles are above the mean outcomes with bonds. The median DC wealth at retirement with the all-stocks portfolio exceeds the 90th percentile outcome with a nominal government bond portfolio.

The next two rows in each panel consider portfolios with a 50 percent stock allocation and the balance invested in either TIPS or nominal government bonds. At most quantiles these investment strategies result in significantly lower levels of retirement wealth than stocks alone. The mean outcome of an all-stock portfolio is 2.3 times larger than the mean with 50/50 TIPS and stocks, and 2.1 times as large as the mean with 50-50 stocks and nominal government bonds. Even at the 10th percentile, an all-stock portfolio outperforms a 50-50 stock/TIPS portfolio by 20 percent. The 50/50 portfolios yield larger DC wealth accumulations than the all-stock portfolios only at the lowest quantiles of the distribution.

The last two horizontal panels of Table 5 consider "lifecycle fund" allocation strategies with either stocks and TIPS or stocks and nominal bonds. Even though we assume greater expense ratios with these strategies than with our earlier ones, the lifecycle funds yield slightly higher average values of DC wealth accumulation than their 50-50 counterparts. This reflects a greater average equity exposure than the 50-50 funds. The higher expenses of the lifecycle funds nevertheless translate into lower values of the lower quantile outcomes for these strategies than for the 50-50 allocation rules. These findings underscore the importance of expenses for analyzing the risk of DC plan wealth accumulation.

The last three columns in Table 5 assume that future equity returns average 300 basis points less than their historical values. The DC plan accumulations for the all-stock strategy are affected more than any other strategy by this modification. Average DC wealth at retirement for the all-stock strategy falls from $918,900 to $452,300. The tenth (first) percentile wealth value drops from $127,000 ($39,300) to $66,300 ($21,200). With the all-stock portfolio, and to lesser degree with other portfolios that have some equity exposure, there is a small chance of a very poor outcome. This outcome becomes poorer when the average equity return is reduced.

Table 6 presents results that are similar to those in Table 5, but it explores two aspects of the robustness of our findings. The first set of results, shown in Panel A, remove cross-sectional variation in the share of earnings contributed to the DC plan. All households contribute at the sample average rate. Comparing the results across tables offers some insight on how much of the dispersion in DC plan outcomes is due to “plan risk” and how much is due to asset return risk and earnings trajectory risk. The mean DC wealth for each investment strategy in Table 6 equals that for Table 5, except for small differences that are below the numerical precision of our simulation algorithm. Within education-asset allocation strategy cells, however, the lower percentile outcomes are worse in Table 5 than in Table 6. This is because in Table 5, it is possible for a low contribution rate to be randomly matched with a low return trajectory, thereby leading to a small accumulation of DC wealth. For related reasons, involving favorable returns paired with favorable contribution shares, the upper percentiles in each category are higher in Table 5 than in Table 6. PRVW (2006) present tables with even more extreme quantiles that underscore these points.

The second panel in Table 6 presents results analogous to those in Table 5 but uses HRS earnings histories adjusted for DB and DC pension accruals. These results are very similar to those in Table 5, suggesting that the impact of the pension accrual correction is modest at best.

We also explored, but do not report, a third check for the robustness of our findings. We replaced the deterministic choice of asset allocation rule in each set of simulations with a distribution of asset allocation rules. For example, we compared the distribution of DC plan balances with a 50-50 stock-bond allocation rule, with the distribution when one quarter of DC plan participants hold only equity, one quarter hold only bonds, and the remaining half hold a 50-50 portfolio. The distribution of DC plan balances becomes more dispersed. The tenth percentile of the distribution when everyone follows a 50-50 allocation rule is $73,100, while the tenth percentile when we use a three-point distribution of possible asset allocation rules is $61,700. Similarly, the 90th percentile value in the former case is $598,200, while in the latter (three-point distribution) case it is $704,300.

4.2 DB Balances at Retirement

We present the PDV of DB accumulations separately for private sector and public sector plans. Table 7 shows the distribution of average DB plan balances, where the averaging is across different plans, for the households in our sub-sample. Our baseline results, presented in the upper panel of Table 7, are based on earnings records without any adjustment for pension accruals. We again stratify individuals by education group. Table 7 reports the mean PDV of DB wealth at age 63 as well as four points in the distribution of DB wealth outcomes. In summarizing our findings, we again focus primarily on those with a high school degree but not a college degree.

The results in the first panel of Table 7 highlight the substantial differences between the benefit accruals for private-sector and public-sector plans. For the high school educated group, the mean DB plan accrual at age 63 is $156,000 for the sample of private sector plans and $316,800 for public sector plans. The proportional differences are even larger for those in other education categories. The results also show that the mean level of DB wealth accumulation in private sector DB plans is lower than the mean wealth accumulation in DC plans, even when DC plan assets are invested conservatively in riskless inflation-indexed bonds. For a high-school educated worker, the mean (median) value of the DB pension accrual at retirement is $156,000 ($150,600), compared with $177,000 ($167,400) for a TIPS-invested DC plan. If the DC plan is invested partly in corporate equities, so that the expected return is higher, then the disparity between the means in the DB and the DC plans is even greater. The upper end of the distribution of DC plan balances is greater than the upper tail of the DB plan accumulations for all of the asset allocation rules that we consider.

The comparison between private sector DC plans and public sector DB plans is more subtle. On average, public sector DB plans are more generous than private sector plans. The mean and median DB public sector plan accruals exceed the mean and median for conservatively-invested DC plans. The median public sector DB plan accumulation, $326,800 for an individual with a high school education, is more than eighty percent greater than the median DC plan accrual for a comparable individual who invests DC plan assets in taxable government bonds ($176,200) or TIPS ($167,400). The public sector DB plan accruals are also slightly larger than those for DC plan participants who invest 50-50 in stocks and TIPS, with a median DC balance in that case of $321,000. The median public sector DB plan accrual is slightly less than the median accrual in a DC plan invested 50-50 in stocks and nominal bonds,

$336,600. However, the median public sector DB accrual is quite a bit less than the median accrual in a DC plan invested 100 percent in stocks, $533,300. The comparison between public sector DB plans and private sector DC plans is even more favorable to the former when average equity returns are reduced by 300 basis points relative to historical returns.

The lower panel of Table 7 presents DB pension accruals calculated from earnings histories that are adjusted for pension accruals. Like our findings for DC plans, the results based on the two sets of earnings trajectories are very similar. The "adjusted" earnings trajectories yield lower DB accruals than the unadjusted earnings, because the average employer-provided DB plan accrual represents a larger share of earnings than the average employer contribution to a DC plan. When we divide the earnings of DC plan participant by the ratio (1+c)/(1+b), described above, we therefore reduce the level of their earnings. With a lower earnings history, the value of the DB plan accrual declines.

5. Comparing Risks in DC and DB Plans

Our findings suggest that mean and median DC plan accruals exceed the comparable measures for private sector DB plans for all of the asset allocation rules that provide some equity exposure. The lowest percentile outcomes for DC plans are nevertheless lower than the lowest percentiles for DB plans. This suggests that conditional on participating in DC plans throughout a working career, there is a non-trivial risk of facing low investment returns and a low share of earnings contributed to the DC plan. At the tenth percentile of the retirement wealth accumulation distribution, the DC plan outcomes that include stocks exceed the DB plan outcomes in both the private and public sectors, but DC plan outcomes that exclude stocks fall short of DB plan outcomes.

An explicit comparison of the expected lifetime utility associated with DB and DC plans requires careful delineation of the sources of risk inherent to each pension structure, and the way individuals may adapt their behavior in response to various shocks. One would need to recognize the potential endogeneity of the set of workers who choose to work at firms that offer DB plans, and the possibility that these workers are a self-selected group who anticipate less job turnover than workers who choose to work at DC plans. Similarly, within DC plans one would need to recognize that workers may differ in their risk aversion, and that more risk tolerant workers may choose more risky asset allocations.

In PRVW (2006), we report certainty equivalent measures for the DC and DB pension accruals under the assumption that households can be described by constant relative risk aversion utility-of-wealth functions with the same risk aversion parameter for all households. We find the certain value of either DB or DC wealth at retirement that would generate the same utility value as the expected utility value across the various DB or DC accrual outcomes. The certainty equivalent calculations are sensitive to the treatment of other stocks of wealth, such as Social Security benefits and household non-retirement financial assets, that provide a buffer against the possibility of very low wealth retirement wealth outcomes in the event of frequent job changes for DB plans, or low equity market returns for DC plans.

Although our certainty equivalent calculations rely on many assumptions and must be viewed in that light, they suggest that for plausible parameter values, the certainty-equivalent value of retirement wealth accruals associated with DC plans is substantially greater than the certainty equivalent value of working under a regime of private-sector DB plans. For a risk neutral individual, there are no scenarios under which drawing a DB plan randomly from the distribution of private sector plans leads to a certainty equivalent that is higher than that associated with drawing a DC plan from the plan population. As risk aversion increases, the value of the DB plan rises, because the tail outcomes with DB plans are not as disperse as those with DC plans.

For a risk-averse individual, the relative performance of DC versus public DB plans is dependent on the equity return assumptions for the DC plan, the level of education for the participant, and the participant's level of risk aversion. For an individual with a high school education and relative risk aversion of one or two, if equity returns follow their historical empirical distribution, the certainty equivalent outcomes of all of the DC plan accruals that involve some equity exposure exceeds the certainty equivalent of the public sector DB plan. At higher risk aversion values, or when the average return on stocks is reduced by 300 basis points, sufficiently risk-averse individuals may achieve higher certainty equivalents in public sector DB plans than in DC plans.

6. Conclusions

This paper presents new evidence on the expected value of retirement wealth accruals under defined benefit (DB) and defined contribution (DC) retirement plans, and on the dispersion of such accruals. We use actual retirement plans that cover respondents in the Health and Retirement Study, and compute prospective wealth accruals using the actual earnings and employment history of these respondents. Our calculations recognize variation in retirement wealth accruals due to: (i) variation in which plan the individual's employer will offer; (ii) differences in the individual's employment history and earnings trajectory; and (iii) variation in the returns earned by investments held in DC plans. We compare, in a similar framework, the asset market risk facing participants in DC plans and the employment history risk facing DB plan participants. We find substantial differences in the generosity of DB plans in the public and private sectors, and present separate results for these two cases.

Our estimates of the average level of wealth accumulated in DC plans depend on how the participant allocates assets across different investment options. Private sector DB plans almost always yield lower average retirement wealth accumulation than private DC plans, although they are also less likely to generate very low retirement wealth outcomes. The comparison between public sector DB plans and representative private sector DC plans is more difficult. If equity returns follow their historical empirical distribution, an individual in a DC plan who makes substantial equity investments will usually achieve a higher retirement wealth in a DC plan than in a public sector DB plan. If equity returns are 300 basis points lower than their historical empirical distribution, it is possible that the distribution of outcomes with the DC plan may look less attractive than the DB plan for some risk-averse households.

Our findings represent a first step toward comparing the relative risks of DB and DC plans using actual earnings histories rather than parametric forms for the earnings and job change process. A natural next step in our research involves comparing the distribution of actual DB and DC wealth in the HRS with the distributions that emerge from our simulations. Since we are using the actual earnings histories of HRS respondents, if respondents are matched randomly to pension plans, as we assume, and if the pension plan environment has been stationary through the working life of the HRS respondents, which it has not been, then the observed distribution should be similar to the one generated by our simulations. Because most HRS retirees with assets in DC plans participated in these plans for only a fraction, and in some cases a small fraction, of their work life, an appropriate comparison would require modifying the simulation algorithm to allow for part-career DC plan exposure. This is a natural direction for further work.

There are many ways in which our algorithm for computing retirement wealth could be extended and improved. For example, we do not allow for lump sum distributions from DC plans that may exert a potentially important drag on retirement wealth accumulation. Engelhardt (2002) finds little evidence that distributions have resulted in significant pension leakage. Poterba, Venti, and Wise (1998b) also find that these distributions are small, perhaps smaller than 401(k) plan administrative costs. However, Poterba, Venti, and Wise (2007) estimate that leakages are somewhat more important. We have not allowed for differences in asset allocation patterns as a function of individual characteristics, such as education, even though past research such as Ameriks and Zeldes (2004) suggests that there are such differences. We do not allow earnings trajectories or the length of the work life to respond to the structure of pension arrangements, even though Friedberg and Webb (2005) suggest that DC plan participants have longer work lives than their DB counterparts, at least potentially because of the retirement incentives that are incorporated in many DB plans. We have not considered the possibility of restrictions on investment decisions in DC plans, such as requirements that participants hold part of their account in company stock. This may increase the volatility of the equity investments held by DC plan participants. We have not considered the role of corporate changes in pension arrangements, such as the risk of a DB plan “freeze” or even a plan termination. This would add additional dispersion to our distribution of retirement wealth outcomes. We have not explored the role of death in affecting the accrual value of pension assets, even though premature death can have very different effects on DB and DC plan benefits, when viewed from the perspective of an bequest recipient. Finally, for evaluating the link between pension accruals and household welfare, there are unresolved conceptual issues associated with the measurement of non-retirement wealth available to households. Consider the case of housing wealth. If such wealth is a potential source of retirement income support, then the potential cost of a relatively low DB and DC plan accrual may be much lower than if housing wealth cannot be tapped in retirement. Addressing these issues will add greater realism to our simulation algorithm.

References

Ameriks, John anda Stephen Zeldes, 2004, "Do Household Portfolio Shares Vary with Age?," Columbia University Graduate School of Business.

Balcer, Yves, and Izzet Sahin, 1979, "A Study of Private Pensions in Ontario," Institute for Research on Poverty Discussion Paper, University of Wisconsin – Madison.

Bodie, Zvi, Alan Marcus, and Robert Merton, 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).

Buessing, Marric and Mauricio Soto, 2006, "The State of Private Pensions: Current 5500 Data," Issue Brief 42, Center for Retirement Research, Boston College.

Campbell, John Y., 2001, Forecasting Equity Returns in the 21st Century, mimeo, Harvard University.

Cunningham, Chris, Gary Engelhardt, and Anil Kumar, forthcoming, "Measuring Pension Wealth," in Olivia Mitchell, Beth Soldo, and Brigitte Madrian, eds., Redefining Retirement: How Will Boomers Fare? (Oxford: Oxford University Press).

Engelhardt, Gary, 2002, "Pre-Retirement Lump Sum Pension Distributions and Retirement Income Security: Evidence from the Health and Retirement Study," National Tax Journal 55, 665-686.

Friedberg, Leora and Anthony Webb, 2005, "Retirement and the Evolution of Pension Structure," Journal of Human Resources 40, 281-308.

Gruber, Jonathan, 1994, "The Incidence of Mandated Maternity Benefits," American Economic Review 84, 622-641.

Gustman, Alan L., Olivia S. Mitchell, Andrew A. Samwick, and Thomas L. Steinmeier, 2000, "Evaluating Pension Entitlements," in Olivia S. Mitchell, P. Brett Hammond, and Anna M. Rappaport, eds., Forecasting Retirement Needs and Retirement Wealth (Philadelphia: University of Pennsylvania Press), 309-326.

Gustman, Alan and Thomas Steinmeier, 2004, "What People Don't Know About Their Pensions and Social Security," in William Gale, John Shoven, and Mark Warshawsky, eds., Private Pensions and Public Policies (Washington: Brookings Institution), 57-125.

Haider, Steven and Gary Solon. 2000. "Nonrandom Selection in the HRS Social Security Earnings Sample," mimeo, University of Michigan.

Hortaçsu, Ali and Chad Syverson, 2004, "Search Costs, Product Differentiation, and Welfare Effects of Entry: A Case Study of S&P 500 Index Funds," Quarterly Journal of Economics 119(4), 403-456.

Holden, Sarah and Jack VanDerhei, 2001, "Contribution Behavior of 401(k) Participants," EBRI Issue Brief No 231 October.

Ibbotson Associates, 2004, Stocks, Bonds, Bills, and Inflation: 2003 Yearbook: Market Results for 1926-2003. (Chicago: Ibbotson Associates).

Marquez, Jessica, 2005, "Lifecycle Funds Can Help Companies Mitigate Risk and Boost Employee Savings," Workforce Management, April, 65-67.

Moore, James F. and Olivia S. Mitchell, 2000, "Projected Retirement Wealth and Savings Adequacy in the Health and Retirement Study," in O. S. Mitchell, B. Hammond, and A. Rappaport, eds., Forecasting Retirement Needs and Retirement Wealth (Philadelphia: University of Pennsylvania Press), 68-94.

Munnell, Alicia and Mauricio Soto, 2007, "Why Are Companies Freezing Their Pensions?," mimeo, Boston College Center for Retirement Research.

Munnell, Alicia and Annika Sunden, 2004, Coming Up Short: The Challenge of 401(k) Plans (Washington: Brookings Institution).

Peticolas, Bob and Helena Stolyarova, 2003, "Pension Estimation Program Users Guide," Working Paper, University of Michigan Institute for Social Research.

Poterba, James, Joshua Rauh, Steven Venti and David Wise, 2005, "Utility Evaluation of Risk in Retirement Savings Accounts," in David Wise (ed), Analyses in the Economics of Aging, Volume 10, University of Chicago Press.

Poterba, James, Joshua Rauh, Steven Venti and David Wise, 2006, "Defined Contribution Plans, Defined Benefit Plans, and the Accumulation of Retirement Wealth," NBER Working Paper 12597.

Poterba, James, Joshua Rauh, Steven Venti, and David Wise, forthcoming, "Lifecycle Asset Allocation Strategies and the Distribution of 401(k) Retirement Wealth." In D. Wise, ed., Developments in the Economics of Aging (Chicago: University of Chicago Press).

Poterba, James, Steven Venti, and David Wise, 1998a, "Implications of Rising Personal Retirement Saving," in D. Wise, ed., Frontiers in the Economics of Aging (Chicago: University of Chicago Press), 85-105.

Poterba, James, Steven Venti, and David Wise, 1998b, "Lump-Sum Distributions from Retirement Saving Plans: Receipt and Utilization," in D. Wise, ed., Inquiries in the Economics of Aging (Chicago: University of Chicago Press), 85-105.

Poterba, James, Steven Venti, and David Wise, 2007, "Rise of 401(k) Plans, Lifetime Earnings, and Wealth at Retirement," NBER Working Paper 13091.

Rohwedder, Susann, 2003, "Measuring Pension Wealth in the HRS: Employer and Self-Reports," mimeo, RAND Corporation.

Samwick, Andrew and Jonathan Skinner, 2004, "How Will 401(k) Plans Affect Retirement Income?" American Economic Review 94, 329-343.

Scholz, J. Karl, Ananth Seshadri, and Surachrai Khitatrakun, 2006, "Are Americans Saving 'Optimally' for Retirement?," Journal of Political Economy 114, 607-643.

Schrager, Allison, 2006, "A Life-Cycle Analysis of the Decline of Defined Benefit Plans and Job Tenure," Columbia University Working Paper.

Shiller, Robert, 2005, "The Life Cycle Personal Accounts Proposal for Social Security: A Review," NBER Working Paper 11300.

U.S. Census Bureau, 2006, "Number and Membership of State and Local Government Employee-Retirement Systems by State," http://www.census.gov/govs/retire/2004ret05a.html.

Table 1: Sub-Sample Selection, HRS Households

	All Households, Head 59-72	Households 59-72, with SS Earnings	Couples 59-72, with SS Earnings	Couples 63-72, with SS Earnings
Household Head Education Less Than High School				
Survey Households	1579	1086	540	374
Population Counterpart (thousands)	3769.3	2653.4	1324.2	938.3
Household Head High School Education and/or Some College				
Survey Households	2793	1954	1076	689
Population Counterpart (thousands)	7669.2	5453.6	3013.2	1949.3
Household Head at least College Degree				
Survey Households	1132	793	526	337
Population Counterpart (thousands)	3411.6	2390.6	1611.8	1013.6
Total				
Survey Households	5504	3833	2142	1400
Population Counterpart (thousands)	14850.1	10497.6	5949.2	3901.1

Source: Authors' tabulations based on the 2000 wave of the HRS and the Social Security earnings histories available for a sub-sample of HRS respondents. Population counterparts are calculated using the household weights provided in the HRS and are stated in thousands of individuals.

Table 2: Wealth Distribution for HRS Couples with Husbands Aged 63-72, Normalized to Age 63/64 in Year 2000 ($000s)

Wealth Component	Full Sample	Less Than High School Degree	High School and/or Some College	College and/or Postgraduate
		20th percentile		
SSW + Annuity	177.3	163.4	188.9	165.7
DB Accumulation	0	0	0	0
DC Accumulation	0	0	0	4.2
Other Financial Assets	0.9	0	1.6	29.6
Net Housing Equity	34.6	6.0	40.4	61.3
Other Wealth	6.0	2.5	7.4	9.6
Net Worth	302.0	220.9	315.1	448.1
		40th percentile		
SSW + Annuity	245.8	228.0	246.8	270.1
DB Accumulation	0	0	0	0
DC Accumulation	8	0	8	45.0
Other Financial Assets	28.0	2.0	28.8	110.0
Net Housing Equity	76.5	45.3	78.8	106.1
Other Wealth	14.0	7.2	15.9	17.5
Net Worth	450.1	323.2	450.4	707.9
		50th percentile - Median		
SSW + Annuity	264.1	247.9	264.1	286.9
DB Accumulation	0	0	0	0
DC Accumulation	22.7	0	20.4	81.7
Other Financial Assets	58.0	6.4	55.7	170.5
Net Housing Equity	92.6	60.2	90.9	125.0
Other Wealth	18.1	11.0	20.0	21.9
Net Worth	536.8	370.1	531.1	856.3
		60th percentile		
SSW + Annuity	264.1	261.4	282.0	309.6
DB Accumulation	0	0	0	0
DC Accumulation	46.5	6.9	40.3	124.6
Other Financial Assets	105.3	18.2	98.0	264.3
Net Housing Equity	109.4	79.6	104.1	153.4
Other Wealth	23.0	15.9	24.1	30.0
Net Worth	637.4	441.3	622.1	1051.3
		80th percentile		
SSW + Annuity	329.5	294.3	321.0	368.0
DB Accumulation	0	0	12.0	65.1
DC Accumulation	148.0	58.2	118.9	349.7
Other Financial Assets	215.2	120.0	223.3	600.0
Net Housing Equity	167.3	113.6	153.1	230.8
Other Wealth	40.0	26.5	39.4	59.3
Net Worth	994.5	644.1	866.4	1598.6
		Sample Mean		
SSW + Annuity	251.5	229.9	250.9	272.7
DB Accumulation	47.7	33.9	44.4	66.6
DC Accumulation	136.4	36.7	83.1	330.9
Other Financial Assets	199.7	69.6	138.7	437.3
Net Housing Equity	115.3	78.7	106.6	165.7
Other Wealth	33.0	19.2	30.1	51.3
Net Worth	783.4	468.1	653.7	1324.5

Source: Authors' tabulations from the 2000 HRS. DB pension wealth was calculated from the pension wealth imputations from the HRS (March 2005 version). Social security and annuity wealth were computed as in PRVW (2005).

Table 3: Combined Employer and Employee Contributions to DC Plans, Percentage of Earnings, HRS Married Men with Positive DC Contributions

Decile	Within-Decile Mean	Upper Bound
1	1.83	2.88
2	3.70	4.23
3	4.81	5.28
4	5.86	6.31
5	7.10	7.71
6	8.54	9.00
7	9.72	10.04
8	10.94	11.97
9	13.30	14.91
10	17.09	31.11

Source: Tabulations courtesy of Anil Kumar using 1992 HRS administrative data and the approach outlined in Cunningham, Engelhardt, and Kumar (2007).

Table 4: Distribution of Job Lengths for Jobs Imputed Number of Jobs During the Working Career, Stratified by Education Level of HRS Respondent
Distribution of Job Lengths, by Education Level of Individual

	Less Than High School Degree	High School and/or Some College	College and/or Postgraduate
10%	6	6	6
25%	11	12	12
50%	25	27	24
75%	33	34	34
90%	35	35	35
Mean	22.3	22.8	22.4

Source: Authors’ imputations using algorithm described in the text.

Table 5: Distribution of DC Plan Balances at Retirement ($2000) Simulating Using Individual-Specific Draws from the Distribution of DC Contribution Rates as a Share of Pay

	Historical Stock Returns			Historical Returns Reduced 300 Basis Points		
Investment Strategy/ Percentile	Less Than High School Degree	High School and/or Some College	College and/or Postgraduate	Less Than High School Degree	High School and/or Some College	College and/or Postgraduate
100% TIPS						
1	27.3	39.1	55.5	27.3	39.1	55.5
10	41.9	58.6	85.6	41.9	58.6	85.6
50	117.1	167.4	236.0	117.1	167.4	236.0
90	225.7	325.5	462.7	225.7	325.5	462.7
Mean	123.7	177.0	251.6	123.7	177.0	251.6
100% Nominal Government Bonds						
1	18.2	26.1	37.9	18.2	26.1	37.9
10	41.2	58.7	83.9	41.2	58.7	83.9
50	123.1	176.2	249.8	123.1	176.2	249.8
90	286.0	410.9	571.8	286.0	410.9	571.8
Mean	148.8	213.4	299.4	148.8	213.4	299.4
100% Stocks						
1	27.3	39.3	55.2	14.9	21.2	31.2
10	88.1	127.0	173.4	46.3	66.3	94.6
50	367.1	533.3	705.4	186.5	268.5	370.5
90	1411.5	2066.0	2640.9	695.8	1008.1	1335.9
Mean	627.7	918.9	1182.5	312.0	452.3	604.3
50% Stocks, 50% TIPS						
1	31.7	45.5	63.3	23.1	33.1	47.1
10	73.0	105.2	143.9	52.8	75.8	106.0
50	222.5	321.0	436.6	160.4	230.5	320.5
90	525.5	760.6	1017.7	376.0	541.6	740.2
Mean	270.5	391.1	526.8	194.2	279.5	384.7
50% Stocks, 50% Nominal Bonds						
1	29.6	42.7	59.6	21.6	31.1	44.4
10	73.6	105.8	145.4	53.3	76.4	107.2
50	233.3	336.6	457.0	167.9	241.2	334.8
90	601.0	871.4	1156.6	428.3	617.9	837.1
Mean	299.0	433.0	579.9	214.0	308.4	421.9
Empirical Lifecycle, Stocks and TIPS						
1	30.1	43.1	60.3	21.2	30.2	43.6
10	72.3	104.2	142.5	50.0	71.6	100.8
50	225.1	325.4	439.9	153.9	221.1	307.8
90	564.5	820.9	1081.2	377.9	545.5	739.5
Mean	284.1	412.7	548.6	191.8	276.7	378.9
Empirical Lifecycle, Stocks and Nominal Bonds						
1	28.2	40.5	56.7	19.9	28.4	41.0
10	71.8	103.3	141.8	49.7	71.1	100.4
50	232.2	335.6	453.1	158.5	227.6	316.6
90	626.5	912.8	1196.6	418.4	605.1	816.4
Mean	307.0	446.3	591.5	206.8	298.5	407.3

Source: Authors' tabulations of simulation results. See text for further details.

Table 6: Sensitivity Results for Distribution of DC Plan Balances at Retirement ($2000)

Investment Strategy/ Percentile	Historical Stock Returns			Historical Returns Reduced 300 Basis Points		
	Less Than High School Degree	High School and/or Some College	College and/or Postgraduate	Less Than High School Degree	High School and/or Some College	College and/or Postgraduate
Panel A: Reported HRS Earnings Histories, All Participants Contributing at Sample Average Contribution Rate						
100% TIPS	123.7	177.0	251.5	123.7	177.0	251.5
100% Nominal Government Bonds						
10	82.8	118.2	171.7	82.8	118.2	171.7
50	135.1	193.4	273.4	135.1	193.4	273.4
90	230.9	332.1	457.4	230.9	332.1	457.4
Mean	148.8	213.4	299.3	148.8	213.4	299.3
100% Stocks						
10	138.7	199.7	276.1	73.8	105.4	153.0
50	422.3	613.8	809.1	213.8	307.8	423.0
90	1321.9	1936.9	2457.3	648.6	940.4	1235.4
Mean	627.9	919.0	1181.8	312.1	452.3	604.0
50% Stocks, 50% TIPS						
10	144.1	207.0	287.8	105.1	150.4	214.0
50	246.8	356.4	483.1	177.7	255.5	354.1
90	426.0	617.5	818.4	303.5	437.8	592.1
Mean	270.5	391.2	526.6	194.2	279.5	384.6
50% Stocks, 50% Nominal Bonds						
10	136.2	195.7	272.8	99.4	142.3	203.1
50	260.8	376.5	509.3	187.4	269.4	372.4
90	507.5	737.1	968.8	360.3	520.7	698.0
Mean	299.1	433.1	579.6	214.0	308.5	421.7
Empirical Lifecycle, Stocks and TIPS						
10	137.1	196.8	275.1	96.4	137.6	198.4
50	250.2	362.2	487.0	170.5	245.1	339.6
90	471.2	687.7	894.1	312.6	452.8	605.2
Mean	284.2	412.8	548.4	191.9	276.7	378.7
Empirical Lifecycle, Stocks and Nominal Bonds						
10	129.8	186.4	260.6	91.1	130.1	187.8
50	259.9	376.1	505.5	176.9	254.2	352.1
90	538.6	786.5	1020.7	357.2	517.6	690.0
Mean	307.1	446.4	591.2	206.8	298.6	407.1
Panel B: Earnings Trajectories Adjusted For DB or DC Accruals, Distribution of DC Contribution Rates						
100% TIPS						
10	40.3	59.0	85.2	40.3	59.0	85.2
50	116.2	166.7	239.1	116.2	166.7	239.1
90	197.4	283.9	404.6	197.4	283.9	404.6
Mean	123.0	176.9	252.2	123.0	176.9	252.2
100% Nominal Government Bonds						
10	40.9	58.7	84.0	40.9	58.7	84.0
50	122.5	176.3	250.4	122.5	176.3	250.4

90	284.7	410.9	573.3	284.7	410.9	573.3
Mean	148.0	213.4	299.9	148.0	213.4	299.9
100% Stocks						
10	87.6	127.0	174.0	46.1	66.3	94.9
50	365.5	533.2	706.7	185.7	268.4	371.0
90	1404.8	2068.4	2644.6	692.5	1009.2	1337.7
Mean	625.1	919.1	1184.2	310.7	452.3	605.1
50% Stocks, 50% TIPS						
10	72.6	105.1	144.2	52.5	75.8	106.3
50	221.3	321.0	437.4	159.6	230.4	321.0
90	523.0	761.1	1020.3	374.2	541.9	742.1
Mean	269.1	391.0	527.8	193.2	279.4	385.4
50% Stocks, 50% Nominal Bonds						
10	73.2	105.9	145.6	53.0	76.4	107.4
50	232.0	336.6	457.5	167.0	241.2	335.2
90	598.1	871.8	1159.7	426.2	618.3	839.7
Mean	297.5	433.0	580.8	212.9	308.4	422.5
Empirical Lifecycle, Stocks and TIPS						
10	71.9	104.2	142.8	49.7	71.6	101.0
50	223.9	325.4	440.5	153.1	221.0	308.3
90	561.6	821.8	1083.3	375.9	546.1	741.1
Mean	282.7	412.7	549.6	190.9	276.7	379.6
Empirical Lifecycle, Stocks and Nominal Bonds						
10	71.4	103.3	142.0	49.4	71.1	100.6
50	230.9	335.6	453.7	157.7	227.6	317.0
90	623.7	913.3	1199.4	416.7	605.6	818.3
Mean	305.6	446.3	592.4	205.8	298.5	407.9

Source: Authors' tabulations of simulation results. See text for further details.

Table 7: Distribution of Defined Benefit Pension Values at Retirement ($000s measured in $2000)

	HRS-Reported Earnings Histories					
	Private Sector Plans			Public Sector Plans		
Percentile	Less Than High School Degree	High School and/or Some College	College and/or Postgraduate	Less Than High School Degree	High School and/or Some College	College and/or Postgraduate
1	51.6	60.4	67.1	35.8	40.1	40.4
10	67.3	86.6	108.3	134.6	186.7	322.5
50	110.1	150.6	260.1	232.0	326.8	563.4
90	185.1	237.4	406.5	303.3	424.8	734.7
Mean	118.0	156.0	255.5	226.7	316.8	544.7

	Pension Accrual Adjusted Earnings Histories					
	Private Sector Plans			Public Sector Plans		
Percentile	Less Than High School Degree	High School and/or Some College	College and/or Postgraduate	Less Than High School Degree	High School and/or Some College	College and/or Postgraduate
1	50.2	59.5	66.6	35.7	40.0	40.2
10	65.0	84.4	106.8	129.1	180.0	311.8
50	106.0	145.6	251.3	222.3	314.8	544.3
90	180.8	230.3	392.5	290.8	409.4	710.0
Mean	114.4	151.1	247.5	217.4	305.3	526.4

Source: Authors' tabulations of simulation results. See text for further details.

Figure 1a: 25th Percentile Earnings, After Top-Coding Correction, HRS Husbands

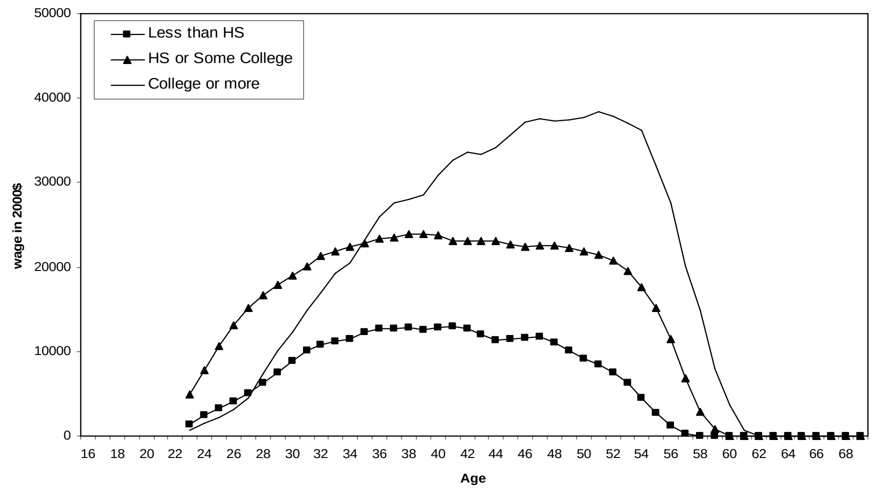

Figure 1b: 50th Percentile Earnings, After Top-Coding Correction, HRS Husbands

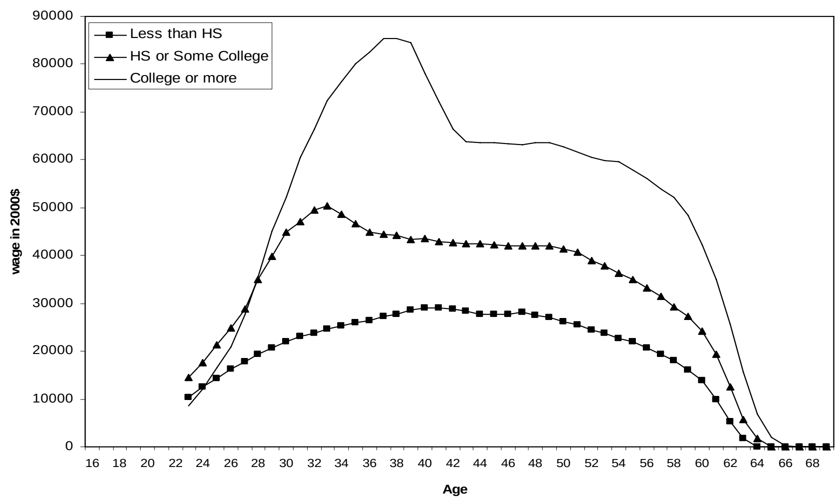

Figure 1c: 75th Percentile Earnings, After Top-Coding Correction, HRS Husbands