Part III
New Roles for Retirement Assets

Chapter 9

The Impact of Pensions on Nonpension Investment Choices

Leora Friedberg and Anthony Webb

Workers have experienced a major shift in pension coverage over the last two decades, with US employer-provided defined contribution (DC) pensions displacing traditional defined benefit (DB) pensions. At the time, the rate of stock market participation among US households escalated. The DB and the DC plans differ in how risks are allocated to workers and firms and in the degree to which workers are exposed to financial decision-making. This chapter documents the investment choices of workers outside their company pensions, focusing on a sample of respondents to the Health and Retirement Study (HRS). In what follows, we first discuss the long-term trends in pension structure and stock market participation by households. Next, we discuss the risks involved in DB and DC pensions and theoretical predictions about their impact on behavior; following this, we review related literature. Subsequently, we present our estimation strategy, data, and estimation results, and conclude with a discussion of directions for future research.

Motivation

Employer-provided DC pensions including 401(k) plans have displaced traditional DB pensions for many US workers over the last two decades. Among full-time employees with a pension, DC coverage rose over 1983–98 from 40 to 79 percent, while DB coverage dropped from 87 to 44 percent (Friedberg and Webb 2005). During the same period, the rate of stock market participation among US households escalated, jumping from 32 percent in 1989 to 49 percent in 1998 (Bertaut and Starr-McCluer 2000). While the proliferation of DC plans explains part of the overall increase in stock market participation, it also rose for other households.[1] Hence, of special interest is how investment choices *outside of worker pension plans* changed over time.

This shift in pension structure has transformed the environment in which workers make most of their life-cycle saving decisions. In times

gone by, employers offering DB plans made all investment choices and bore risks associated with those choices. Today, employees generally make investment choices and bear the associated risks in DC plans. For instance, an unexpectedly high rate of return helps employers with DB plans and workers with DC pensions. Conventional theory suggests that workers with DC plans, bearing more investment risk, should invest more conservatively outside of their pensions than workers with risk-free DB plans. Yet DB plans have traditionally imposed substantial risks as well. The promised benefit is often not fully guaranteed until the worker nears or reaches retirement, so the DB pension risk should also influence workers' willingness to bear nonpension investment risk, especially since it is likely to be correlated with salary risk they bear.

The allocation of household nonpension portfolio risk may also be influenced by other pension risks. One possibility is that the proliferation of DC pensions *raised* stock market participation outside of pensions, perhaps by helping households overcome barriers to stock market participation (Poterba 2001; Weisbenner 2002). Another factor to consider is taxes. Rational investors are believed to do best when they put taxable assets in DC plans where they are taxed less heavily (Bergstresser and Poterba 2004). Especially for those in higher tax brackets, the same pretax rate of return earned on bonds will be taxed more heavily than that earned on equity. On the other hand, equity historically has a higher average pretax return, so predictions about the optimal location of assets may be ambiguous. We will consider what the evidence reveals about these effects.

Our research provides a key ingredient for understanding the impact of pension structure on overall wealth accumulation. Many researchers have analyzed how people make investment choices in DC plans. However, data from pension plan managers and employers does not allow one to analyze the resulting impact on nonpension wealth. Another branch of research has used data like ours from the HRS or the Survey of Consumer Finances (SCF) to study how the presence or amount of wealth in pension plans relates to the *amount* of nonpension wealth. Little attention has been given, though, to understanding the effect of pensions on the *allocation* of nonpension wealth. By influencing rates of return and the subsequent need to save, the allocation of wealth determines total wealth at retirement. Poterba et al. (2005) laid out the impact of allocation choices in DC plans on retirement wealth and expected utility while treating the allocation of nonpension wealth as exogenous. Their work demonstrates the importance of understanding responses to risk that alter other wealth holdings. The question of whether the structure of pensions lead people to make offsetting choices in the allocation of their nonpension portfolio will drastically affect conclusions about the impact of pensions on overall wealth at retirement.

It is also important to understand these effects for several additional reasons. First, our results shed light on the overall impact of major changes in the pension environment, since DB pension coverage continues to plummet for young workers and in newer jobs. Second, there is increasing attention to how the shift in pension risk may alter other behavior such as retirement patterns. The extent to which real actions are taken to offset such risk is governed by the opportunities to make other portfolio adjustments. Third, the shift in pension structure may provide new insights about the importance of constraints on portfolio allocation. Finally, some reform proposals recommend replacing at least a portion of traditional Social Security benefits with personal accounts. The latter may raise wealth if they earn a higher return than the 2–3 percent real return by which social Security benefits would be reduced (President's Commission to Strengthen Social Security 2001). Yet if participants responded to this change by reallocating their nonpension portfolios away from equities, much of the anticipated risk diversification benefit might disappear. At the other extreme, events like the collapse of Enron have led to calls to reduce the amount of risk to which workers are exposed in their pensions.

Predictions from Economic Theory

From a theoretical perspective, DB and DC pensions differ in crucial ways. Figure 9-1 shows the path of pension wealth accrual in two such plans drawn from the HRS.[2] Pension wealth here is defined as the real discounted present value of the worker's expected future pension benefits, if the job ends at the age shown on the horizontal axis. In this section, we first describe differences in the risks associated with the accrual of pension wealth in both types of plan shown in Figure 9-1, and then we offer predictions about the impact of those risks on optimal portfolio choices. We also discuss theoretical considerations about voluntary contributions, which are often difficult to identify in practice.

Risk Characteristics of Pension Plans

The DC pensions are relatively simple to explain: contributions go into an account which earns a market return. The account is portable after vesting (usually immediate or within two years), so workers can 'roll over' or take their funds with them as a lump-sum, when they leave their job. Some DC plans are invested entirely in company stock or another risky asset, while many allow some choice in how to invest their funds. While the nature of the investment risk varies to some extent across plans, workers bear the investment risk in all DC plans. Thus, the path of DC pension wealth

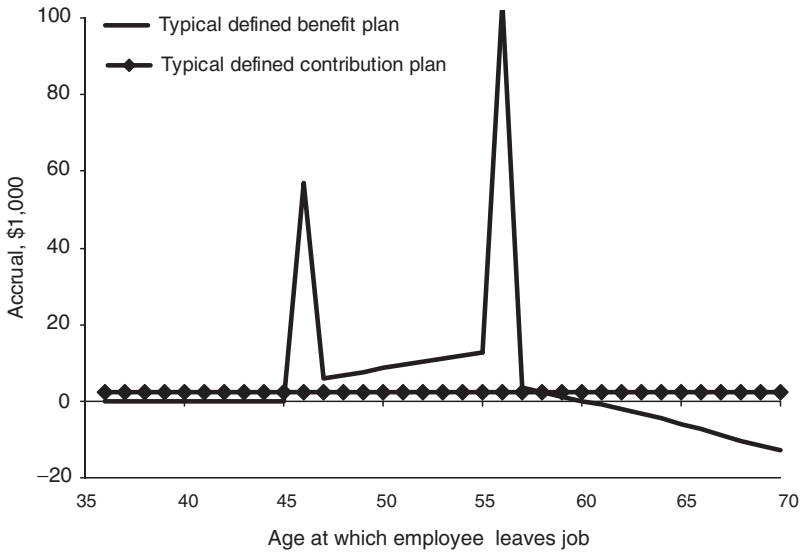

Figure 9-1. Pension wealth accruals in typical pension plans, 1992 HRS. *Notes:* Employer-provided pension wealth is defined as the real present value of expected future employer-provided pension benefits, if the employee leaves the job at the age shown on the horizontal axis. Pension wealth accrual, shown on the vertical axis in thousands of dollars, is the change in pension wealth if the employee works one additional year and then leaves the job. (*Source*: Adapted from Friedberg and Webb (2005).)

accrual shown in Figure 9-1 is not actually known in advance, but is in fact uncertain.

The DB pensions offer a defined payout to workers at retirement. The benefit is typically an annuity that is a proportion of either the worker's average or final salary, with the proportion often increasing with tenure. In the United States, corporate employers are obligated to prefinance promised benefits in a manner that is financially sound, so they bear the resulting investment risk.[3] The DB plans are not actually riskless, of course; the path of DB pension wealth shown in Figure 9-1 is 'spiky', which makes DB pension wealth highly vulnerable to the risk of early departure, in contrast with portable DC pensions. Losses from early exit arise because benefits depend on nominal, not real, earnings; because of nonlinear effects of job tenure on the nominal benefit; and because of vesting provisions. The risk of losing one's pension because of early departure from a job shrinks as tenure increases, both because expected pension wealth is realized and because uncertainty over future contingencies may diminish. Accordingly,

the pension risk in DB plans diminishes over time, while the investment risk in DC pensions remains.[4]

How Pensions Affect Optimal Portfolio Choice

In a standard model of portfolio choice without frictions, risk-averse individuals choose an optimal combination of expected return and undiversifiable capital market risk that depends on their degree of risk aversion. All other risk that arises from investing in capital markets can be diversified away by making investments that have negatively correlated risks. What if people face risk in their income streams as well as their investments? This 'background' income risk is generally viewed as being undiversifiable, and it will generally reduce the amount of risk that people are willing to absorb in their financial assets. Labor income is considered a major source of background risk.

The full impact of risky pensions will depend on the nature of those risks. As noted, DB and DC pensions are both subject to background risk from uncertain future earnings highly correlated with labor income risk, and DB pensions are subject to additional background risk due to possible early departure from the job. Given that, paying workers with a risky flow in either the form of a pension or its equivalent in cash would, at the outset, induce similar effects on portfolio choices. However, since these sources of background risk diminish over time, this could boost the risk people are willing to adopt outside their pension. This prediction is stronger for DB pensions because of the diminishing risk of early departure and the accruals of DB wealth that workers experience as tenure increases. Besides that, DC pensions carry investment risk. Giving a worker a risky DC plan instead of a safe DB plan should lead to offsetting behaviors elsewhere.

To sum up, if workers make optimal portfolio choices, then we expect that workers holding risky assets in their DC plans should adopt more conservative investment strategies outside their pensions, and workers with DB plans should adopt accordingly less conservative strategies.

The Effect of Pensions on Optimal Portfolio Choice with Frictions

Recent behavioral economics studies have suggested that many US households do not invest in equity markets at all, even if equity is recommended theoretically as a key element of any optimal portfolio in the absence of a risk-free asset. Explanations for barriers to stock market participation include costs of participation, whether financial, informational, or psychological. A related piece of evidence is that stock market participation jumped in the 1990s, perhaps because the proliferation of DC plans played

a role in surmounting some barriers to participation. If households face an up-front cost of learning how to invest or acquiring information, then DC plan participants with investment choices can overcome that barrier. In point of fact, DC participants are usually offered information about investment choices such as risk characteristics and past performance of different types of mutual funds, and they can learn from observing performance over time. Even being given an investment such as company stock without choice may raise awareness about the operation of financial markets. Moreover, some employers seek to boost DC participation in order to comply with tax law by offering financial education, which has been shown to lift contributions to retirement accounts (Bernheim and Garrett 2003; Duflo and Saez 2003).[5] Weisbenner (2002) found some evidence of this, where he concluded that households with DC plans permitting investment choices were more likely to hold equities and held a higher share of equities outside of their plans, than otherwise similar households in DC plans that did not permit such choices.

Taxes

The portfolio allocation problem gains an additional dimension when considering DC plans, since assets held in such accounts are taxed lightly.[6] Investors should therefore locate assets that are taxable at the highest rates in DC plans, subject to liquidity constraints. The same pretax rate of return earned on bonds tends to be taxed more heavily than that earned on equity, especially at higher tax rates, though the tax differential was much greater in 2004 than in 1992.[7] On the other hand, equity historically has a higher average pretax return than bonds. Thus, we might observe different nonpension portfolio allocations for people with DB versus DC plans for tax-related reasons. The differential in tax rates should encourage the concentration of bonds in DC plans and equity outside, while differential rates of return would lead to offsetting effects. However, research by Bergstresser and Poterba (2004) indicates that tax minimization is not a major driver of DC versus non-DC allocations.

Voluntary Contributions

A final consideration is that some DC plans allow voluntary contributions, and in some cases these are matched by an employer. In a frictionless world, if we observed voluntary contributions, we would predict that workers would continue to offset the riskiness of their pension wealth elsewhere in their portfolio. In a world with barriers to stock market participation, on the other hand, observing voluntary contributions to a risky asset reveals important information. If such contributions were not otherwise

encouraged by matching employer contributions or tax preferences, it provides additional support for the notion we discussed earlier—that DC pensions offer a less costly way to invest in risky assets. Additional motivations from taxes or employer match rates that subsidize such investments mitigate this argument, but not fully. Unfortunately, it is difficult to observe voluntary and matched contributions in the HRS. Below, we highlight what we can infer in our estimation approach.

Related Literature

One important set of papers relevant to our topic analyzes the theoretical effect of various risks on portfolio choices and real behaviors in a life-cycle setting. Many recent papers have analyzed the impact of adding undiversifiable 'background' income risk to the household problem, including Kimball (1991) who shows that an increase in income risk in a static framework reduces an agent's willingness to bear investment risk, even when the risks are independent. The implication is that, when a risky DC plan replaces a safe DB plan, individuals who also face background risk should seek safer assets outside of their pension. Background risk also can induce agents to take other actions. For instance these features reduce both consumption and investment in the risky asset (cf. Koo 1998, 1999) in simulations of dynamic models with income risk and borrowing constraints. Viceira (2001) incorporated exogenous retirement, while Chan and Viceira (2000) allowed labor supply to vary endogenously, which mitigates but does not eliminate the demand for hedging when stock and labor income shocks are positively correlated.[8]

It should be noted that much of the theoretical literature on optimal allocation in the face of background risk focuses only on financial assets. We extend the focus to pension wealth, which is facilitated by our recognition that pension risks closely resemble risks in either labor income or financial wealth. We will follow the lead of others and ignore housing and self-owned businesses, but some features of our analysis reduce concerns along those lines. Flavin and Yamashita (2002) showed that introducing housing can cause substantial differences in optimal stock holdings over the life cycle, but age-related heterogeneity is not a major problem in our sample of older workers. Also, households with closely held businesses are less likely than others to have pensions at all because they are disproportionately self-employed.

Limitations of Empirical Research

Empirical researchers have avoided estimating a full life-cycle problem like those laid out in the theoretical literature, focusing instead on testing

limited implications. One reason is that actual behavior departs from theoretical predictions in important ways. Many papers have assessed the magnitude of departures from theoretical predictions, but the explanations for them remain highly unclear. A common finding is that stock market participation is far too low (King and Leape 1987) and that individuals actively rebalance their portfolio far too infrequently (Ameriks and Zeldes 2004), relative to theoretical predictions. Explanations have focused on barriers to stock market participation, which we alluded to earlier. For example, Vissing-Jørgenson (2002) found that stock market participation is persistent and that the frequency of trades increases with income, which may indicate the importance of fixed per-period participation costs.

Another problem is the nature of available data, which limits the scope of empirical analysis. Some studies use data from financial companies, occasionally longitudinal, but they lack information on nonpension behavior or on many household characteristics that affect financial behavior. Other studies use the SCF, which collects detailed wealth data for repeated cross-sections. The first panel to collect detailed asset data was the HRS. We use data from the HRS, but we use it cross-sectionally because of measurement error. Measuring changes in asset values magnifies the difficulties involved in measuring asset levels, which are already subject to substantial misresponse and nonresponse in survey data.[9]

Empirical Research on Portfolio Behavior

To study portfolio allocation, we are particularly interested in studies that focus on DC pension plans and other assets together, and those that focus on the impact of risk. In the former category, Uccello (2000) noted that 401(k) participants with a DB plan were more likely to invest their 401(k) assets in equities, as compared to those without a DB plan. While the allocation of pension and nonpension investments is endogenous, she controlled for the allocation of nonpension investments to stocks. In what follows, we extend the focus to the determinants of non-DC investments. Poterba and Samwick (2003) carefully estimated the impact of marginal tax rates on the allocation of assets to tax-deferred accounts [including 401(k) plans] and other accounts, though not on allocations within tax-deferred accounts. Below, we follow many of the details of their empirical specifications. In addition, Bergstresser and Poterba (2004) studied whether tax considerations appear to drive allocations in and out of DC plans. While people with DC plans in our data hold more equity outside of their pensions than people with DB plans, Bergstresser and Poterba showed that people with DC plans in the SCF also hold more equity in their DC accounts, and that DC and non-DC allocations are typically quite similar. Since relatively

small reallocations would be required for many households to achieve tax-efficient portfolios, their work suggests that tax minimization does not drive DC versus non-DC allocations.

A separate group of papers found that measures of *ex ante* risk or *ex post* outcomes of risky processes influence portfolio choices. Guiso et al. (1996) showed that higher self-reported labor income risk is associated with smaller holdings of equity in Italian data. Vissing-Jørgenson (2002) found that higher volatility in nonfinancial income is associated with a reduced share of assets in the stock market, and Souleles (1999) reported similar effects of consumption volatility. Vissing-Jørgenson did not find, however, that the correlation of income and stock market returns influenced allocations. Below, we directly extend this literature by analyzing the impact of exposure to pension risk on portfolio choices.

A few recent papers have analyzed risk-taking in the HRS. Goldman and Maestas (2005) found that households that are more likely to have Medigap policies to supplement Medicare, and thus face reduced risk of out-of-pocket medical expenditures, are more likely to invest in risky assets. Benítez-Silva (2004) estimated that work flexibility, as measured by the ease with which one can alter one's work hours, raised holdings of equity in the HRS. He interpreted the results as showing that those who can self-insure their labor income by adjusting hours of work are more willing to take on other risks. Our analysis on pension risks, which are substantial, extends these results.

Empirical Research on Other Effects of Risk

Several studies have analyzed the impact of recent stock market fluctuations on retirement, with very mixed results. Gustman and Steinmeier (2002) estimated a structural model of retirement and saving in the HRS with stochastic rates of return, but they did not model portfolio choices. Coronado and Perozek (2003) found that the stock market run-up led to earlier-than-planned retirement in the HRS. Other papers specifically exploited variation in exposure to stock market risk through DC pensions. Hurd and Reti (2001) and Coile and Levine (2004) did not find evidence of an effect on retirement, while Sevak (2005) did.

Methodology and Estimation Strategy

As we have noted, DB and DC pensions carry different risks and opportunities. DB pensions grow relatively less risky over time, so we expect to see a gradual increase in exposure to risk outside of DB pensions. On the other hand, the proliferation of DC plans may have helped to boost

stock market participation in the 1990s. Next, we describe our approach to studying these effects.

Econometric Specifications

Using cross-sectional data from the first wave of the HRS, we will investigate the impact of pension type on the riskiness of nonpension investments.[10] Specifically we examine the probability of holding equities in nonpension financial assets and the share of nonpension financial assets allocated to equities.[11] The estimation is based on an underlying latent variable model in which s^* indicates the desired share of assets allocated to equity but is subject to censoring at the endpoints of 0 and 1, as follows:

$$s_i^* = X_i\beta + \varepsilon_i$$

$$s_i = 0 \quad \text{if } s_i^* < 0, \quad s_i = s_i^* = X_i\beta + \varepsilon_i \quad \text{if } s_i^* \in [0, 1], \quad s_i = 1 \quad \text{if } s_i^* > 1$$

Here, X consists of pension characteristics and other explanatory variables that may affect portfolio choices, as we discuss later. A Tobit specification assumes that the probability density function $f(\varepsilon_i) \sim N(0, \sigma^2)$. A Probit specification assumes the same thing and estimates the likelihood of $s_i > 0$ versus $s_i = 0$, in which case σ^2 is not identified.

Identifying the Effect of Pension Risk

In order to distinguish the effects of pension risk, we control for both the type of pension and years in that type of plan, and whether DC plans offer investment choices. We remain concerned, though, about unobserved factors that may be correlated with pension characteristics and undermine inference about the effect of pension risk on portfolio allocations. For example, workers who are relatively risk-tolerant may sort into jobs with risky DC plans, or workers who are more likely to leave a job early may prefer a job that offers a portable DC plan and may also be more risk-tolerant. Unfortunately, we lack instruments for pension characteristics, so we will take other steps to address concerns about unobserved heterogeneity. We will focus on a relatively homogeneous sample of workers with a pension (as in Weisbenner 2002). People without a pension differ in many dimensions—they have lower income and wealth and are less likely to be working full-time. Many are retired, and retirement may cause portfolio changes that confound the analysis. We therefore also control for answers to HRS questions about tolerance for risk.

We remain hesitant to ascribe a causal interpretation to the estimated effect of pension type on stock market investment, however. Concerns

about endogenous selection into pension type are exacerbated by the recognition that participation in some DC plans is voluntary. Ideally, we would either omit DC plans that were purely voluntary, or focus on DC eligibility rather than DC participation, or else use information on voluntary contributions to gain insight about preferences for risky investments. Unfortunately, we cannot readily identify voluntary contributions to DC plans in our data, and we are not confident that we observe all those who are eligible but do not participate—that is, we can verify nonparticipating eligibles whose employers report another pension, but we must rely on individual reports for nonparticipating eligibles who report having no other pension. This issue will compound the problem of unobserved heterogeneity in risk preferences.

On the other hand, the possibility of endogenous selection of workers into pension plans works in our favor in identifying years-in-plan effects. Our hypothesis is that workers will take on more nonpension risk the longer they stay in a DB plan. Endogenous mobility would confound inference of such an effect if workers with a greater tolerance for risk stay longer in jobs with DB plans. However, this is the opposite of what follows from our arguments above—we expect workers with less tolerance for risk to choose DB plans and to stay in them longer. Therefore, concerns about endogenous mobility would bias against finding evidence supporting our hypothesis, and any effect that we observe would underestimate the true effect.

Empirical Evidence

Our empirical analysis sheds light on these issues by investigating the investment allocations of workers with DB or DC pensions. The Health and Retirement Study reports detailed data for a large sample of older Americans on wealth holdings and on pension plans. We use data from 1992 and 2004 to compare workers with different types of pension plans, and we incorporate information on the number of years workers have been in their pensions. This allows us to distinguish effects on stock market investment that are present immediately from effects that emerge as time in the plan increases. If DB pension wealth were riskless, then workers with DB plans would be expected to take on more risk elsewhere in their portfolios. Viewing DB pensions more accurately as risky, but declining in risk as tenure increases and DB pension wealth becomes more certain, then workers with DB plans should take on more risk over time. In our empirical results, we observe this effect—stock market participation is significantly higher as years in a DB plan rise, relative to years in a DC plan. We confirm in our 1992 data that DB pension wealth at risk diminishes rapidly as

workers age through their 50s. We also find that years spent in either type of plan reduce stock market investment in 2004 when compared to 1992. This suggests a jump in the perceived risk of both types of pensions. This is not surprising given both increasingly common reports of underfunding of DB plans, and also recent experience with stock market volatility among DC plan holders in 2004.

The HRS surveyed households with at least one spouse aged 50–60 in 1991. Analyzing a large sample in this age range is useful, since they are in their peak saving years and most likely to be making active decisions about the allocation of wealth. We focus on the original HRS cohort in 1992, when it was aged 51–61, and we replicate some of the analysis for the War Babies (WBs) and Early Baby Boomers (EBBs) cohorts using 2004 data, when those cohorts were aged 51–62. The key advantage of data from 1992 is that the HRS also obtained information from employers about pension coverage at the time, as we describe below. Similar data is lacking for the later cohorts in 2004.[12]

Investment Data

The HRS collected data on specific assets through questions of the following type, which asked in 1992 about equity holdings:

> For the next few questions, please exclude any assets held in the form of IRA and Keogh accounts. Do you have any shares of stock in publicly held corporations, mutual funds, or investment trusts?

Respondents were then asked the total amount invested in assets of this kind. Similar data were collected on other types of financial assets including holdings of any kind of bonds (comprising 'corporate, municipal, government, or foreign bonds, or any bond funds') and liquid assets (comprising 'checking or savings accounts, or money market funds', and, 'certificates of deposit, government savings bonds, or Treasury bills'). Data were also collected about the balances of IRAs and Keoghs, but not about their asset allocation until 1998, so we have excluded them.

An important feature that distinguishes the HRS from many other datasets is the degree to which it sought to obtain at least some information from people who refused to answer these questions in full. When respondents said they had an asset but refused to provide its value, they were prompted to reveal the range in which the value lay. The HRS used the range data to impute dollar amounts for both partially and completely missing responses. We use the imputed values when actual values were not obtained.

Pension Data

The HRS offers two sources of data about pensions. People were asked in detail about their pensions, and in 1992 they were also asked to give permission for the HRS to contact their employer to get plan information. The HRS obtained plan descriptions from employers of 65 percent of workers who said they had a pension.[13]

It turns out that many people are surprisingly unfamiliar with details of their pensions. Gustman and Steinmeier (1999) underscore that people confuse even the type of pension they have: among the 48 percent of their employers reporting that they offered only a DB plan, 56 percent of the workers in such a plan described it as DB, while 15 percent described it as DC, and 27 percent said they had both types. Mistakes were similarly high among employers reporting that they offered only DC plans or reporting both types. This raises the question of how to use these two sources of information: much more accurate employer-reported (ER) data for a smaller, and possibly selected, sample; and much less accurate individual-reported data for the full sample. Complicating the situation, only workers report key variables for our analysis—how long they have been in their plans and whether they have investment choices in DC plans. For our 1992 sample, we try various combinations of self- and employer-reported data on pension type and pension wealth, motivated by the recognition that even incorrect beliefs can affect behavior.[14] Chan and Stevens (2004) found that inaccurate information about pensions affects retirement decisions, as does accurate information among those who are well-informed. For the 2004 sample, of course, we can only use self-reported data.

Other Data

We include other explanatory variables that are expected to influence portfolio choices. The HRS asked questions about preferences for risk-taking. Individuals were first asked,

> Suppose that you are the only income earner in the family, and you have a good job guaranteed to give you your current family income every year for life. You are given the opportunity to take a new and equally good job, with a 50-50 chance it will double your family income and a 50-50 chance that it will cut your family income by a third. Would you take the new job?

After answering yes or no, they were asked a similar question proposing either a more or less risky gamble. We explored different parameterizations of this information, but the controls for risk aversion are statistically significant in only some of our empirical specifications. People may have difficulty processing this somewhat complicated hypothetical.[15] Therefore,

the responses may not capture the full range of heterogeneity in risk preferences.

Our other control variables are relatively standard. As in other studies, we control for noncapital income and wealth. Because labor income and pensions both comprise a part of compensation, we control separately for labor income and for other noncapital income and separately for employer-provided pension wealth and for other components of net nonpension wealth. While net nonpension wealth may be endogenously determined by past portfolio choices, it is commonly included and has strong explanatory power. It is justified by, among other things, the possibility of fixed costs of participation, since higher wealth makes it easier to surmount such costs. Employer-provided pension wealth is defined here, differently from Figure 9-1, as the expected present value of benefits if a worker stays in a job until age 65.

We can control for information about current health status and about life expectancy until ages 75 and 85, with the latter capturing information about the value to individuals of annuitized DB pension income versus unannuitized DC lump-sum payouts. Finally, we will include demographic variables (age, marital status, gender, and educational attainment) that influence life-cycle behavior.

Sample Selection

We concentrate on the effect of men's pensions, and we treat the household as the decision unit. On the whole, men are much more likely to have a pension in the original HRS cohort—about 40 percent of our 1992 sample has a wife with a pension, and wives' pension wealth is relatively low. Studying wives' pensions, as well as household decision-making more generally, is complicated by evidence from our other research; for instance, Friedberg and Webb (2006) show that the spouse with higher earnings has more influence over major household decisions, and moreover that women with more influence invest significantly less in the stock market.

Of the 7,607 households interviewed in the HRS cohort in 1992, we focus on those in which a male is working (4,138 households); and among those, men who are not self-employed and who report having a pension (2,271); and among those, households that report the data discussed above (1989); and among those, households with positive net nonpension wealth (1950).[16] Of the 6,034 households interviewed in the WB and EBB cohorts in 2004, we employ the same criteria, focusing on those in which a male is working (2,010), the male is not self-employed (1,550), the household has positive net nonpension wealth (1,461), and the male reports having a pension (1,019). For our main sample of 1,950 in 1992, 1,343 were

matched to ER data. As we noted earlier, we will make use of pension data reported both by workers and, when available, their employers. Of those 1,343, some 706 of the workers (or 51%) knew their pension type (categorized as DB-only, DC-only, and DB and DC)). Mistakes can be of several types. Fully 11 percent of the matched sample are completely confused, reporting DB-only when the plan is DC-only or vice versa; 19 percent are somewhat confused, reporting both types when they only have one; and 18 percent are absentminded, reporting one type when they have both.

Characteristics of the Sample

Tables 9-1 and 9-2 reports summary statistics for our full sample and relevant subsamples. Table 9-1 shows summary statistics for the full sample, divided by self-reported (SR) pension type; and for the subsample that has matched employer data, divided by ER pension type. Table 9-2 reports key financial statistics (excluding IRAs and Keoghs, as mentioned earlier) for additional subsamples.

There are two notable patterns that emerge among the pension and financial variables of interest in the 1992 sample. First, people with DC plans (with or without a DB plan as well) had a greater likelihood of investing in equities than did people with only a DB plan. Among those in the SR data with a DB-only plan, 28.9 percent owned stock outside their pension, compared to 38.1 percent of those with a DC-only plan and 47.7 percent with DB and DC plans. For the matched subsample using ER data, the overall differences were less stark (34.3% for DB-only, 40.4% for DC-only, and 39.3% for DB and DC); while for those in the matched sample who knew their pension type (as shown in Table 9-2), the differences were a little more stark (26.6, 42.9, and 52.6). Conditional on investing, though, there was little difference in the share of financial assets allocated to equities.

The second key pattern is that, among those with DB plans in 1992, the likelihood of investing in equities rose with years in the plan. Table 9-2 distinguishes among those in DB plans for 0–10 versus 11+ years for self-reported samples (since, importantly, only SR data reports years in a plan). For workers in DB-only plans, 23.4 percent in their plan for 0–10 years invested in equities versus 30.7 percent in their plan for 11+ years. For workers in DB and DC plans, the differences (by years in the DB plan) were 41.8 and 49.9 percent.

As our results in the next section confirm, the two key patterns described above persist when we control for covariates in the estimation. This is important because of disparities in some sample characteristics shown in

TABLE 9-1 Key Characteristics of HRS Sample

	1992						*2004*		
	Self-Reported Pension Type			*Employer-Reported Pension Type*			*Self-Reported Pension Type*		
	DB-Only	*DC-Only*	*DB and DC*	*DB-Only*	*DC-Only*	*DB and DC*	*DB-Only*	*DC-Only*	*DB and DC*
Wealth and income in thousands of $2004									
Labor income	49.1	54.3	66.5	54.5	56.2	59.8	55.7	64.4	78.7
Other noncapital income	20.5	22.3	22.9	22.1	24.0	20.5	24.4	31.3	32.2
Net nonpension wealth	212.8	235.4	272.3	216.5	267.3	242.7	341.2	374.2	564.2
Employer pension wealth	165.9	91.2	288.7	291.4	181.9	336.1	80.9	140.0	237.9
Stock ownership outside of employer-provided pension									
% Owning stock	28.9	38.1	47.7	34.3	40.4	39.3	37.3	37.7	45.3
Stock/nonpension financial wealth	15.4	19.8	25.5	17.9	22.4	21.6	22.1	23.7	27.6
" " , if own stock	53.2	52.0	53.6	52.3	55.5	55.0	59.2	62.8	60.9
Employer-provided pension characteristics									
Years in DB plan	19.4	—	19.1	—	—	—	19.7	—	14.5
Years in DC plan	—	9.8	8.4	—	—	—	—	10.0	10.9
DC plan has choice	—	51.1	63.5	—	—	—	—	81.9	76.2
Demographic and other characteristics									
Most risk averse	70.9	63.0	66.7	70.0	57.9	72.6	60.6	58.0	55.0
Married	87.9	89.1	88.3	85.7	91.4	86.7	86.3	89.4	88.5
Age	56	55	55	55	56	55	55	54	54
No high school	25.4	28.3	12.5	20.6	21.9	19.3	12.7	11.7	5.5
Attended college	39.3	44.3	59.2	49.8	48.6	49.3	63.0	63.2	70.9
Black	16.6	10.9	8.7	14.3	11.6	12.8	15.8	8.8	10.2
Hispanic	6.2	7.4	4.5	6.9	5.1	3.7	9.5	10.6	8.4
Bad health	1.8	1.3	1.0	0.6	0.7	2.6	0.4	0.9	0.8
Sample size	820	530	600	621	292	430	284	443	382

Source: Authors' calculations from the 1992 HRS.

Notes: The sample includes all households in which a male works, is not self-employed, and reports having a pension, and which have positive net worth and answer all questions about the information reported above. Variable definitions: pension type is defined benefit (DB)-only, defined contribution (DC)-only, or defined benefit and defined contribution; distinct information on pension type is reported by both individuals and by their employers. Labor income, employer-provided pension wealth, and demographic characteristics are reported for the male in the household. See text for more details.

TABLE 9-2 Financial Characteristics of Various Subsamples

	% Owning Stock	Stock/Financial Wealth		Most Risk Averse
		All	If Own Stock	
1992 Full sample, by self-reported (SR) pension type (N = 1,950)				
DB-only (820)	28.9	15.4	53.2	70.9
0–10 yrs	23.4	12.4	53.1	68.5
11+ yrs	30.7	16.3	53.2	71.6
DC-only (530)	38.1	19.8	52.0	63.0
0–10 yrs	35.3	17.8	50.6	60.6
11+ yrs	44.1	24.0	54.3	68.2
DB and DC (600)	47.7	25.5	53.6	66.7
DB 0–10 yrs	41.8	23.1	55.3	66.1
11+ yrs	49.9	26.4	53.0	66.9
Employer reports a pension, by SR pension type (N = 1,343)				
DB-only	34.3	17.9	52.3	70.0
DC-only	40.4	22.4	55.5	57.9
DB and DC	39.3	21.6	55.0	72.6
SR/ER pension type agrees (N = 706)				
DB-only	26.6	12.8	48.2	72.2
0–10 yrs	16.4	7.6	46.4	65.6
11+ yrs	28.8	13.9	48.4	73.6
DC-only	42.9	24.3	56.8	52.2
DB and DC	52.6	29.9	56.9	68.2
DB 0–10 yrs	48.7	28.2	57.9	66.7
DB 11+ yrs	53.6	30.4	56.7	68.6
SR/ER pension type disagrees a little, by SR pension type (N = 505)				
DB-only	27.4	15.1	55.1	76.0
DC-only	39.3	19.9	50.7	75.4
DB and DC	46.0	25.2	54.7	63.4
SR/ER pension type disagrees a lot, by SR pension type (N = 143)				
DB-only	34.3	19.0	55.3	68.6
DC-only	35.6	19.8	55.5	76.7
2004 Full sample, by self-reported (SR) pension type (N = 1,109)				
DB-only (284)	37.3	22.1	59.2	60.6
0–10 yrs	29.9	22.0	73.8	59.7
11+ yrs	40.1	22.1	55.2	60.9
DC-only (443)	37.7	23.7	62.8	58.0
0–10 yrs	35.3	21.5	60.8	58.4
11+ yrs	42.0	27.7	66.0	57.3
DB and DC (382)	45.3	27.6	60.9	55.0
DB 0–10 yrs	43.9	26.1	59.4	52.0
11+ yrs	46.4	28.9	62.2	57.4

Notes: See Table 9-1. Definitions: SR—self-reported pension data. ER—employer-reported pension data. Disagree a little—person misreports DB-only or DC-only as DB and DC, or misreports DB and DC as DB-only or DC-only. Disagree a lot—person misreports DB-only as DC-only or vice versa.

Table 9-1. People who had both types of pensions were richer—with higher earnings, pension wealth, and net worth—than people with one type, and people with DC-only plans were richer than people with DB-only plans. It is crucial to ascertain that it was not higher wealth that drove greater stock market investment.

In addition, the highest degree of risk aversion is observed for those in DB-only plans and the lowest for those in DC-only plans—so this is partly, but not completely, correlated with the pattern in stock market investment, raising concerns that workers who were more tolerant of risk selected into riskier pensions. On the other hand, risk aversion was a little higher among those who have been in their DB pensions the longest. This supports the argument we made earlier that there may be endogenous mobility of the less risk averse out of DB and into DC plans—which would bias downwards the estimated effect of years in a DB plan. Still, the range of variation in risk aversion across pension types was only moderate, with 63–71 percent of each type reporting the highest degree of risk aversion.

Some additional features are noteworthy. The share of the 1992 sample in Table 9-1 who has a wife with a pension is generally similar, at 40–46 percent for each pension type, and it is highest for the DC-only group. This reduces concerns that about our choice to focus mostly on men's pensions. In addition, people in DC plans with choice invested substantially more in the stock market, as did people who had been in their DC plans for longer. These differences related to choice and to years-in-plan for those with DC plans are not sustained when we include other covariates in the estimation, though.

Finally, note that DC pension coverage rose considerably for the 2004 cohort, compared to the 1992 cohort. In 2004, 74 percent of our sample had a DC plan, compared to 58 percent in 1992. In parallel, DB coverage dropped to 51 percent in 2004, down from 73 percent in 1992. While stock market investment at the ages that we focus on did not change much between 1992 and 2004, the differential across pension types narrowed, with a substantial increase among those with only a DB plan and slight decline among those with DC plans. The similarity of conditional stock market investment across types of plans persists, as does the differential by years in a plan.

Taxes

Before proceeding to discuss estimation, we will briefly mention evidence about the potential impact of tax minimization on our analysis. As we noted earlier, nonpension portfolio allocations might differ for people with DB versus DC plans simply for tax-related reasons. On the other hand, results

from Bergstresser and Poterba (2004) suggested that tax efficiency does not seem to play a major role in affecting DC versus non-DC allocations. We find corroborating evidence in the HRS by considering sample selection criteria that parallels that of Bergstresser and Poterba. Beginning with our sample of 1950 in 1992, we select households with nonpension financial wealth of at least $25,000, pension wealth of at least $25,000, and access to a DC plan that allows them to choose the allocation of their assets. The resulting sample of households who are likely to have much to gain from tax minimization consists of only eighty-three observations. Such a small number will have little effect on our overall analysis.

Estimation

The multivariate estimation models described next test whether pension type and years in a plan influence the riskiness of nonpension investments. First, we discuss our simple Probit and Tobit estimates for the main 1992 sample; next, we turn to estimates for additional 1992 and 2004 subsamples; and finally, we discuss robustness checks for the variables used in the basic specification. For Probits we report estimated marginal effects, showing the impact of a marginal change in a covariate on the likelihood of investing in the stock market; for the Tobits, we report estimated coefficients, showing the impact of a marginal change on the 'desired' percentage s_i^* of nonpension financial wealth invested in the stock market.

Main 1992 Sample

Table 9-3 shows estimation results for all covariates, for the main 1992 sample that uses self-reported pension data. The evidence indicates that 37 percent of the SR sample invested in the stock market, and the average of the unconditional share of nonpension financial wealth invested was 19 percent. The control variables in Table 9-3 generally have the expected signs in the Probit and Tobit specifications. Stock market investment rises with wealth and income. While the effect of employer-provided pension wealth was relatively small, the effect of net nonpension wealth was substantial—being in the top quartile of the wealth distribution significantly raises the likelihood of investing in the stock market by 50 percentage points, relative to the bottom quartile. Meanwhile, being in the top 5 percent of the labor income distribution significantly raises the likelihood by 35 percentage points. Being in the most risk-averse category (consisting of about two-thirds of the sample) significantly reduces the likelihood of investing in the stock market by 5.5 percentage points. Households with older men are less likely to invest in the stock market, with the probability falling by a little

TABLE 9-3 Estimation Results, Basic Specification

Independent Variables	*Holds any Stock Outside Pension (Probit)*		*Share of Nonpension Financial Wealth Held in Stock (Tobit)*	
	Marginal Effect	*Standard Error*	*Coefficient*	*Standard Error*
Pension type (omitted: DB-only)				
DC-only	0.1332**	0.0569	0.1507*	0.0825
DB & DC	0.1001***	0.0341	0.1328***	0.0497
DC plan offers choice	0.0040	0.0623	0.0451	0.0914
Years in pension plan				
DB	0.0039***	0.0015	0.0047**	0.0022
DC	0.0010	0.0021	0.0011	0.0031
DC plan offers choice	0.0005	0.0045	0.0001	0.0063
Employer pension wealth, second quartile	0.0710*	0.0376	0.1174**	0.0554
Third quartile	0.0827*	0.0402	0.1462**	0.0584
Top quartile	−0.0401	0.0433	−0.0290	0.0661
Net nonpension wealth, second quartile	0.2033***	0.0295	0.3175***	0.0456
Third quartile	0.3321***	0.0349	0.4747***	0.0531
Top quartile	0.5028***	0.0399	0.6362***	0.0727
Labor income, second quartile	0.0006	0.0288	0.0102	0.0436
Third quartile	0.0483	0.0399	0.1162**	0.0568
Top 75–95%	0.1405*	0.0756	0.2420**	0.0956
Top 95–100%	0.3523***	0.1114	0.3165**	0.1251
Other noncapital income, second quartile	−0.0295	0.0333	−0.0174	0.0500
Third quartile	0.0354	0.0373	0.0768	0.0542
Top 75–95%	0.1138**	0.0569	0.1904**	0.0756
Top 95–100%	0.2103**	0.0939	0.1755	0.1155
Occupation is unskilled	0.0154	0.0331	0.0115	0.0500
Skilled	0.0326	0.0328	0.0249	0.0489
Married	−0.1750	0.1462	−0.2950	0.2036
Age, husband	−0.0073**	0.0033	−0.0110**	0.0049
Age, wife	0.0034	0.0025	0.0058*	0.0037
Risk averse	−0.0547**	0.0257	−0.0326	0.0374
Education < high school	−0.0599*	0.0338	−0.0645	0.0546
Attended college	0.0545*	0.0305	0.0956**	0.0456
Black	−0.1354***	0.0349	−0.2124***	0.0638
Hispanic	−0.1314***	0.0456	−0.1533*	0.0853
Constant	—	—	−0.1306	0.2775
σ	—	—	0.6278	0.0192
Log-likelihood/N	−0.5432		−0.6628	

Source: Authors' calculations from the 1992 HRS.

Notes: Pension type and other information is self-reported (SR), 1992 data. The sample includes households in which a male works, is not self-employed, and reports having a pension, and which have positive net nonpension wealth and answer all questions about the information reported above. Sample size is 1950. See Table 9-1 notes and text for more information.

*p < 0.05; **p < 0.01; ***p < 0.001.

under a percentage point for each year of age. Households with older wives are more likely to invest, with a smaller effect in absolute value. Hispanics and blacks are significantly and substantially less likely to invest in the stock market.

Next, we turn to a discussion of key pension variables. People with DC plans (whether DC-only or DB and DC) are significantly more likely—10–13 percentage points—to invest in the stock market, relative to having a DB-only plan. These effects become a little smaller if years-in-plan variables are excluded, in results that are not shown. Meanwhile, in the Tobit specification these variables lose a little significance but have a slightly greater effect on the desired share of wealth invested in stocks. The other main finding is that years in a DB plan (whether DB-only or DB and DC) also has a statistically significant and positive effect on stock market investment. Each year in a DB plan raises the likelihood of investing in stocks by 0.39 percentage points (standard error of 0.15), or 3.9 percentage points for each 10 years—this amounts to a little over 10 percent of the sample mean rate of stock market investment. In the Tobit specification, each year in a DB plan raises the desired share of wealth in the stock market by 0.48 percentage points.[17] By contrast, the effect of years in a DC plan (whether DC-only or DB and DC) is virtually 0; notably, if we control for years on a job, it does not affect the results. Finally, it is interesting that we do not observe any statistically significant or substantive effect on stock market investment of having investment choices in a DC plan. This occurs whether we assume a constant effect or allow it to vary by years in a plan with choice.

To sum up, we find that workers with DC pensions invested more in the stock market, but independently of how long they have been in their plans. This suggests the presence of either endogenous sorting or an immediate learning effect from DC plans—unfortunately, we are not able to distinguish which. Moreover, the effect of having a DC plan will be overstated, relative to having a DB plan, if people with a greater taste for investing in stocks are more likely to contribute and hence be classified in the first place as having a DC plan. Finally, we find that workers with DB pensions invested more in the stock market over time. As we argued earlier, the presence of endogenous mobility would lead us to underestimate the true effect of years in a DB plan.

Additional 1992 Subsamples

Table 9-4 shows the estimated marginal effects for the key pension variables for various subsamples of the 1992 data that distinguish between self- and employer-reported pension information; this distinction is not possible

TABLE 9-4 Additional Estimation Results

	1992 Data			
	Pension Type is Employer-Reported (ER)		*SR/ER Pension Type Agrees*	
	Probit	*Tobit*	*Probit*	*Tobit*
Pension type				
DC-only	0.0635 (0.0687)	0.1442 (0.1010)	0.2107* (0.1166)	0.3106* (0.1653)
DB and DC	0.1304* (0.0708)	0.1968* (0.1052)	0.3213*** (0.1161)	0.4970*** (0.1704)
DC plan offers choice	—	—	−0.0858 (0.0790)	0.0054 (0.1217)
Years in a pension plan				
DB-only	0.0048** (0.0022)	0.0072** (0.0033)	0.0083*** (0.0032)	0.0140*** (0.0049)
DC-only	0.0045 (0.0030)	0.0054 (0.0045)	0.0068 (0.0051)	0.0090 (0.0070)
DB and DC	0.0009 (0.0024)	0.0021 (0.0037)	0.0022 (0.0038)	0.0045 (0.0054)
N	1,382		706	
Log-likelihood/*N*	−0.5601	−0.6778	−0.5426	−0.6576
	SR/ER disagrees—Pension Type is SR		*SR/ER disagrees—Pension Type is ER*	
DC-only	0.2256** (0.1096)	0.3000** (0.1520)	−0.0129 (0.0995)	−0.0066 (0.1481)
DB and DC	0.0591 (0.0556)	0.0795 (0.0800)	0.0373 (0.0910)	0.0445 (0.1347)
DC plan offers choice	0.0768 (0.1474)	0.1185 (0.1941)	—	—
Years in pension plan (see notes)				
DB	0.0048** (0.0024)	0.0060* (0.0035)	0.0045 (0.0032)	0.0049 (0.0045)
DC	−0.0005 (0.0039)	−0.0013 (0.0055)	0.0043 (0.0041)	0.0050 (0.0061)
DB and DC	—	—	−0.0016 (0.0034)	−0.0022 (0.0051)
N	648		676	
Log-likelihood/*N*	−0.5409	−0.6598	−0.5448	−0.6638

	2004 Data	
	Pension Type is Self-Reported (SR)	
	Probit Marginal Effects (Standard Errors)	*Tobit Coefficients (Standard Errors)*
Pension type		
DC-only	0.0193 (0.0664)	0.0428 (0.1024)
DB and DC	0.1125** (0.0486)	0.1544** (0.0741)
DC plan offers choice	0.0068 (0.0716)	0.0024 (0.1099)
Years in a pension plan		
DB	0.0008 (0.0022)	0.0005 (0.0034)
DC	−0.0049* (0.0027)	−0.0043 (0.0042)
DC plan offers choice	0.0067 (0.0047)	0.0081 (0.0071)
N	1,019	1,019
Log-likelihood/*N*	−0.5516	−0.7162

Notes: Estimation of same specification for subsamples of full sample reported in Table 9-3; see Table 9-3 notes for details. SR—self-reported pension data, ER—employer-reported pension data. SR/ER agrees—sample for which the SR and ER pension type agrees. SR/ER disagrees—sample for which the SR and ER pension type disagrees. When SR and ER pension type disagrees and we use ER data on pension type, we interact ER pension type with maximum years in a plan that individual reports. Selected samples, subset of covariates reported. See also Table 9-3.

using 2004 data. We include the years-in-plan variables, although these effects are more difficult to interpret when we use ER data. Employers do not report years in a plan, so we have interacted the ER plan type with the maximum years in a plan reported by the individual.

The 1992 ER sample, which has pension data provided by employers, consists of about two-thirds of the full SR sample. The effects of pensions, shown in the top panel of Table 9-4 on the left, are similar in magnitude and significance to the SR results discussed above. Having a DC pension raises the likelihood of stock market investment by 6–14 percentage points, and each year in a DB plan significantly raises the likelihood by 0.48 percentage points, a bigger effect than before.

Notably, the effects of pensions are much stronger in the 1992 subsample in which the same pension type is reported by the worker and employer. In this 'agree' subsample, shown in the top panel of Table 9-4 on the right, the effect of having a DC plan is particularly large. People in DC-only plans are 21.1 percentage points (standard error of 11.7) more likely to invest in the stock market than people in DB-only plans, while people in DB and DC plans are 32.1 percentage points (11.6) more likely. The effect of years in a DB plan (again, DB-only or DB and DC) is also larger, with each year raising the likelihood by 0.83 (0.32) percentage points. The length of time in a DC plan is positive and not that much smaller but insignificant, at 0.68 (0.51) percentage points, and this is considerably larger than for the full SR sample.

The estimated effects of pensions may be greater in the 'agree' group for two reasons. People who know their pension type reveal themselves to be more financially savvy and, perhaps, more responsive to pension incentives. However, they may also be more interested in the stock market. Thus, the very large estimated effects of pension type raise extra concern about endogenous selection.

Interestingly, people who are misinformed about their pension type respond to their self-reported pension information sometimes significantly, but less strongly, in results shown in the middle panel of Table 9-4 on the left. In contrast, the estimated effects for the same confused sample when we instead use ER information, in the middle panel on the right, are always statistically insignificant and small.

2004 Sample

The bottom panel of Table 9-4 shows the estimated marginal effects using self-reported pension data for the WB and EBB cohorts in 2004. The estimation results are similar in a key respect to the 1992 results but are different in other interesting ways. The differential between the estimated

effects of tenure in DB versus DC plans remains similar—in both samples, stock market participation is significantly higher as years in a DB plan rise, relative to years in a DC plan. Once again, this suggests that DB plans grow relatively less risky, compared to DC plans, as workers approach retirement and thus gain DB pension wealth accruals.

In addition, the absolute magnitudes of the year-in-plan estimates for 2004 have changed in important, revealing ways. Both estimated years-in-plan effects are substantially smaller than they were in 1992, now indicating a 0.08 percentage point increase (standard error of 2.2) in the likelihood of investing in the stock market for each year in a DB plan and a 0.49 (2.7) percentage point decrease for each year in a DC plan.

The substantial reductions in these estimated effects suggest there was a jump in the risk that people perceive as accumulating over time in both types of pensions. This is not surprising given recent developments. Reports of employers underfunding, freezing, or terminating DB plans have grown common in the last few years, and many plans in some key sectors of the economy have been turned over to the Pension Benefit Guaranty Corporation (PBGC). The PBGC pays off obligations based only on years of service accumulated to date, so many workers lose out on substantial future accruals that they expect; also the maximum payout is capped so that highly compensated employees are only partially insured. Meanwhile, DC plan holders today have had considerable recent experience with stock market volatility. The last finding of note is that people in DC plans with choice invest increasingly in the stock market over time, though the estimated effect falls a little short of statistical significance. This gives stronger support than the 1992 data did to the idea that DC plans may help reduce barriers to stock market participation.

Understanding DB Pension Risks

We complete the analysis by quantifying the risks associated with early exit from DB pensions. The expected loss from early exit depends on two factors—how much pension wealth is at risk (which we compute in the 1992 HRS), and the incidence of unexpected job loss. The latter is difficult to quantify, since we do not observe individual expectations. Instead, we simply used information about reasons for leaving one's job for the original HRS cohort observed in subsequent years. Table 9-5 shows some illustrative results. For people in a DB pension at the outset of the HRS, it shows DB pension wealth at risk by age in 1992 and subsequent reasons for job exits by age. The median pension wealth at risk is very substantial for workers in their early 50s and declines sharply with age. The median loss in pension wealth if someone leaves his job at age 51 is 61.4 percent of total pension

TABLE 9-5 Pension Wealth at Risk in Defined Benefit Plans, 1992 HRS

Age	*% of Job Exits Due to*		*Loss in Pension Wealth if Job Ends Now*		*Actual Loss Due to Involuntary Dismissals*
	Involuntary Dismissal	*Poor Health*	*Median ($)*	*% of Total Pension Wealth*	*Median ($)*
51	2.1	1.3	57,163	61.4	65,594
52	0.8	1.5	54,590	56.8	41,172
53	1.4	2.0	46,312	52.6	36,214
54	0.8	0.6	40,949	47.3	55,910
55	1.0	1.0	31,783	39.4	53,670
56	1.4	1.0	27,616	34.6	11,546
57	0.9	0.7	23,398	29.4	63,820
58	1.7	1.6	19,496	23.0	15,592
59	0.6	1.4	14,705	10.9	14,898
60	1.7	1.5	9,366	11.7	10,071
61	1.4	1.4	7,914	9.1	5,354
62	1.0	2.0	5,854	6.9	3,616
63	1.0	1.0	5,175	6.3	3,413
64	2.0	1.0	4,024	5.4	2,126
65	1.9	1.9	1,829	2.8	2,075
66	0.0	0.8	3,585	4.4	0

Source: Authors' calculations from the HRS, 1992–2002.

Notes: Sample: all men in jobs with a defined benefit pension in 1992. Sample size is 1,852. Definitions: pension wealth equals the real present value of an employee's expected future pension benefits, if the employee leaves the job at the age shown on the horizontal axis. Involuntary dismissals are those in which the individual said that he or she quit, had been laid off, or would have been laid off had he not quit.

wealth ($57,163). The median falls to $31,783 at age 55 and $9,336 at age 60.[18] On the other hand, the rate of involuntary job loss is low, at around 1–2 percent per year among people who started the year in the job, and does not show a clear age-related pattern.[19] Another 1–2 percent per year left their job at each age because of poor health or disability, which might also be considered by voluntary. While the rate of involuntary job loss might be low, the consequences are severe, as shown in the final column. The median pension loss suffered due to involuntary exits is $65,594 at age 51, and it declines rapidly, falling to $10,071 at age 60.

Conclusions and Discussion

The shift from DB to DC plans over the last two decades has led to important changes in risks borne by workers in their pensions. Employers

make investment choices and bear capital market risks associated with those choices in DB plans, while workers bear capital market risks in DC plans. Of course, many DB pensions also carry the risk of a substantial loss in pension wealth resulting from an unexpectedly early exit from one's job or from termination and bankruptcy. When we consider the impact of these changes in pension structure on the risks workers are willing to absorb in their investment choices outside of their pensions, the main results show significant and substantial differences in stock market investment among workers, depending on their pension characteristics. The longer workers are in their DB plans, the riskier the investments they make outside of their pensions. In comparison, workers with DC plans invest more in the stock market overall—yet this effect is independent of how long they have been in their plans.[20] This pattern suggests that workers with a greater preference for risk (who would invest more in the stock market anyway) sort themselves into jobs with DC pensions. Importantly, this type of sorting would bias against estimating a positive effect on stock market investment of years in a DB plan, since if anything workers staying longer in jobs with DB plans should be more risk averse, according to the sorting hypothesis.

In the more recent data, we find a similar differential in the estimated effects of tenure in DB versus DC plans, so once again it appears that DB plans grow relatively less risky, compared to DC plans, as workers approach retirement and thus gain DB pension wealth accruals. In addition, the absolute magnitudes of the year-in-plan estimates in 2004 have shrunk, suggesting that there was a jump in the risk that people perceive as accumulating over time in both types of pensions.

This research illustrates another of the myriad consequences of the shift in pension structure, which may also alter patterns of job mobility at young and older ages and consumption after retirement. We identify some effects of the shift in investment risk from employers to workers, as well as recent changes in those risks. Moreover, our conclusions shed light on important policy concerns. Some reform proposals would replace at least a portion of traditional Social Security benefits, which have characteristics of DB plans, with personal accounts, which have characteristics of DC plans, thereby shifting investment risk onto workers. Our results indicate that individuals might respond to the jump in risk by reallocating their nonpension portfolios, reducing the boost in retirement wealth which is expected from personal account.

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Notes

[1] Statistics on both pension and stock market trends are computed from the SCF. Also using the SCF, Poterba (2001) reported that the share of the adult population owning stock outside of employer-provided pensions in taxable accounts rose from 31.8 to 48.5 percent between 1989 and 1998, and the share owning stock in Individual Retirement Accounts rose from 10.3 to 20.9 percent.

[2] The pension plans in Figure 9-1 were slightly altered to protect confidentiality (see Friedberg and Webb 2005).

[3] Cash balance plans are hybrids. Workers accrue a notional contribution and rate of return which may be fixed or tied to economic indicators or company performance, in which case they share the investment risk. Funds are portable after vesting, but the account does not actually exist, and employers follow DB funding rules and bear some or all of the investment risk. They were not common during the 1992 HRS (US General Accounting Office 2000).

[4] Pensions involve other risks as well, but they are less important for our analysis. Both DB and DC plans generally compound risk which workers face in their future earnings. DB pension wealth generally depends on one's last or highest years of earnings, while the whole path of earnings may determine DC contributions. This source of risk in both types of plans also diminishes over time as the uncertain path of earnings is realized, while in DC pensions it is converted into investment risk. The risk of uncertain life spans is usually borne by employers in DB plans since most DB benefits are annuitized, and by workers in DC plans since most DC benefits are not (Brown et al. 1999). We can control for this risk in our estimation and simulations because the HRS reports data on subjective life expectancy. Finally, workers face a risk that their employer's DB pension fund may become insolvent, but their benefits are partially insured by the PBGC. The PBGC guarantees the pension earned at the time of insolvency up to a maximum amount, so it does not shield workers from the early departure risk that we already discussed. The guaranteed amount depends on age and survivorship; for a pension with no survivor benefit payable at age 65, the monthly limit in 2005 was $3,801.

[5] Another explanation is that the stock market boom of the late 1990s altered perceptions, rightly or wrongly, about the riskiness of the stock market, relative to expected returns. Since our estimation uses data from 1992, concerns about a bubble driving up participation are absent.

[6] Income earned on assets in DC plans is taxed on withdrawal rather than when it is earned. This deferral reduces the effective tax rate and also gives some leeway to time withdrawals to coincide with years when the marginal tax rate is low.

[7] Taxing capital gains only on realization reduces the effective tax rate on long-held equity. In addition to that, long-term gains (usually defined as a year or more) have been further favored since 1991. The maximum marginal tax rates in 1992 were 31 percent on other income and 28 percent on capital gains, so the differential was small; maximum rates in 2004 were 35 and 15 percent, with the latter applying to dividend income as well.

[8] We do not extend our focus here to real responses, because DB and DC pensions differ in other important ways that directly affect saving and retirement behavior and may only affect portfolio allocations indirectly, while the differences

in risk should affect portfolio allocations directly and other real behavior only indirectly.

[9] For example, Rohwedder et al. (2004) argued that asset levels in many categories were substantially understated when the initial AHEAD cohort of the HRS was surveyed in 1993, leading to overestimates of saving in subsequent years.

[10] Many of the econometric issues we confront are noted in Miniaci and Weber (2002) and Poterba and Samwick (2003).

[11] Alternately, we could study the allocation of the entire portfolio including pensions. This would be more difficult because the HRS reports only whether DC plans are invested 'mostly in stock, mostly in bonds, or both'.

[12] Except in the case of variables related to number of years in a pension plan and to total pension wealth, we use data from the RAND HRS data files in the interests of comparability with other studies. We obtained very similar estimates for our 1992 sample when using either source of data, obtained from the HRS directly or from RAND.

[13] Some respondents refused to give permission, and some employers failed to reply. We do not know whether workers who report not having a pension (and whom we omit from our data) actually have one, since employers were not contacted in that case. Gustman and Steinmeier (1999) estimated that the likelihood that the HRS obtained employer data rose significantly with education, firm size, self-reported pension wealth, and working in a nonmanufacturing firm, and fell with wealth and earnings. However, the overall explanatory power of these variables was low, so we treat the availability of employer data as exogenous.

[14] Data on pension wealth computed from both self-reported and ER data has been provided by researchers through the HRS/AHEAD website (Anonymous 1998; Peticolas and Steinmeier 1999).

[15] They may have difficulty separating preferences for risk and for other characteristics of their current job in answering the question. The SCF question that Poterba and Samwick (2003) and Weisbenner (2002) used asked whether respondents were willing to take more or less risk to get a greater or smaller expected return.

[16] Among those with a pension, the most common missing data was pension type, other information needed to determine pension wealth, and risk preferences.

[17] As an alternative to assuming a normal distribution and estimating a Tobit, we tried censored quantile regression (CQR; Guiso et al. 1996). Unlike censored least absolute deviations (Powell 1984), CQR is possible when the median itself is censored, as it is in this case. Stata code to estimate CQR was written by Moreira for Chay and Powell (2001). However, the estimation did not converge, suggesting that the model does not explain portfolio allocations in the upper quantiles very well.

[18] The level of pension wealth at any age is sensitive to the assumed interest rate, and we assume a 1.9 percent real rate. The pattern of decline through the 50s is not sensitive to this assumption.

[19] We classify a quit as involuntary if someone said that he or she quit, had been laid off, or would have been laid off had he not quit. Other possible reasons for job exit include family care, better job, or retired.

[20] For a related study in the Swedish context, see Karlsson et al. (this volume).

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