Essays on Private Pensions and Workers' Savings Behavior

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ABSTRACT
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In the last thirty years there has been a considerable change in the way people save for retirement. The once traditional defined benefit plans are steadily being replaced by now dominant defined contribution plans. The new type of plans have effectively shifted the responsibility for retirement saving from the employer to the worker and have thus contributed to the ongoing debate on the adequacy of retirement income and ways to encourage workers to save more. This dissertation studies the role of private pensions on workers’ savings decision in the US and the potential impact of policy interventions.

The first essay (co-authored with Geoffrey Sanzenbacher) documents recent trends in growing pension inequality between high and low-income workers, which has coincided with the shift towards defined contribution type of plans and workers’ voluntary non-participation in such plans. It examines the question whether extending tax-deferred pensions to uncovered low-income workers would result in high rates of pension participation and whether it
would succeed in closing the pension inequality gap. To determine how likely uncovered workers are to participate if given the option, it is important to control for possible self-selection into jobs. Even though the majority of low-income workers currently eligible for a voluntary tax-deferred pension plan choose to participate, it is unclear whether those individuals are representative of low-income workers in general. Our estimation reveals that workers currently offered a tax-deferred pension are more likely than otherwise similar individuals to participate. Thus, current estimates over-predict the fraction of workers who would participate if voluntary retirement plans were extended to them. Ignoring selection would overestimate the percent of all low-income workers that would participate in a tax-deferred savings plan by 25 percent and the remaining pension inequality gap by 8.1 percentage points.

The second essay further explores how not yet implemented policies that change the distribution or incentives of different pension plans would affect saving outcomes. For this purpose, it builds-in the endogeneity of pension coverage into a behavioral model of workers’ employment, consumption and saving decisions in which both wages and pensions are simultaneously determined by workers’ job choice decisions. The model is estimated on the Panel Study of Income Dynamics (PSID) data using the method of indirect inference. Policy simulations indicate that switching from voluntary to mandatory contributions in defined contribution plans would result in lower overall pension coverage and a crowd-out effect with other forms of saving, but an overall 10 percent increase in average wealth accumulations. A complete phaseout of defined benefit plans, on the other hand, would lead to a 3 percent lower overall savings for retirement.
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Chapter 1

Pension Participation and Uncovered Workers

by Nadia Karamcheva and Geoffrey Sanzenbacher

1.1 Introduction

Over the last thirty years, defined contribution (DC) pension plans have become the norm in the private sector, replacing more traditional defined benefit (DB) plans. Unlike DB plans, workers offered a DC plan are not required to participate. While a majority, 61 percent, of low-income workers eligible for a DC plan choose participation, this rate is substantially lower than for high-income individuals. Low participation rates, coupled with low pension coverage mean only a third of low-income workers are actually enrolled in a pension.¹ Low pension enrollment together with future declines in Social Security’s generosity imply that 60 percent of low-income workers are at risk

¹Karamcheva and Sanzenbacher (2010)
of retirement income that cannot maintain their standard of living.\textsuperscript{2} Thus, low pension enrollment amongst low-income workers has become a concern of policymakers; the Obama administration has suggested requiring employers to automatically enroll employees in IRAs. Indeed, they cite majority participation among low-income workers as evidence that such a plan would be effective in ensuring pension coverage. However, caution should be taken when using the participation rates of workers currently covered to infer how workers not covered would respond to the policy change. If searching for a job is costly, then only workers who suspect they will participate in a DC pension would look for a job offering one. For low-income workers, for whom search costs and pension contributions represent a large share of their income, this selection effect may be especially strong. The current literature on pension participation amongst eligible workers does not control for this selection effect.

In departure from previous work on pension participation, we allow that workers offered a defined contribution plan may select into jobs offering plans based on an unobserved propensity to participate. To accomplish this we estimate two Heckman (1979) type selection models, one with participation in the plan as the outcome and one with the individual’s contribution to the plan as the outcome. The first model has been referred to in the literature as bivariate probit with sample selection.\textsuperscript{3} The second specification replaces the

\textsuperscript{2}Munnell et al. (2009)
\textsuperscript{3}See Green (2008). This model consists of two latent variable equations, whose errors have joint normal distribution.
participation variable with the contribution rate of the worker to his defined contribution pension. A person’s contribution rate is a censored continuous variable; the contribution rate is censored below at 0. We estimate this model via maximum likelihood, controlling for both the censoring and sample selection.\textsuperscript{4} In both specifications, the ratio of defined contribution plans to defined benefit plans in an individual’s state of residence is used as the required exclusionary restriction. Thus, the key assumption is that individuals do not move to a state to be more likely to obtain a defined contribution pension plan.\textsuperscript{5}

Our analysis indicates that ignoring selection has two consequences: (1) it overestimates the percent of non-covered workers who would participate in a DC type plan and (2) it underestimates the effect of income on participation and thus the gap in participation between low and high-income individuals that would be still present even if everyone is given access to coverage.

Low participation in DC plans amongst eligible low-income workers is not surprising; participation removes income from the worker’s pay check and requires decisions on risk allocation that low-income workers may have

\textsuperscript{4}We use a STATA routine called “cmp”, which accommodates a variety of conditional mixed processes.

\textsuperscript{5}The results presented in the paper reflect estimation when using a SIPP-derived ratio of defined contribution plans per state. Ideally one would want to use information on availability of pension plans, coming directly from employers. One way is to obtain this variable from IRS Form 5500. See 5500-CRR Data, Panel of Current and Usable Form 5500 Data, Center for Retirement Research at Boston College, available at: http://crr.bc.edu/frequently_requested_data/data_on_the_form_5500_annual_reports.html. Using information from Form 5500 Data in our empirical specification produces results which are similar qualitatively but somewhat different quantitatively. One reason could be that in the IRS forms the reported state of the firm is not necessarily the one where its’ workforce operates. To the extent that those two differ, so would our estimate of the state-level ratio of DC to all pension plans.
difficulty making. Previous literature has found a positive relationship between participation and income for workers offered a defined contribution plan. For example, Huberman et al. (2007) show that an increase in compensation of $10,000 leads to a 3.7 percent increase in the probability of participating in an offered defined contribution plan. Similarly, Bassett et al. (1998) find that a $1,000 increase in family income yields a 0.3 percent increase in the probability of participation in an offered defined contribution plan. Munnell et al. (2009) utilize data from the Survey of Consumer Finances and find a similarly positive relationship between an individual's income and the decision to participate in an offered defined contribution pension. This can be interpreted as the effect of income on pension participation for the group of individuals offered defined contribution plans. This result may not be useful to policy makers who wonder how individuals not being offered plans respond when enrolled in an IRA.6

The results indicate that ignoring the selection into defined contribution jobs leads to estimates for the pension participation equation that do not apply to the population at large. In a probit on individuals offered a defined contribution plan, the marginal effect of log income on participation is 6.7 percent; once controlling for selection that estimate increases to 11.9 percent.

6A crucial difference between the Obama Administration's plan and employer provided DC plans is automatic enrollment. In the Administration's plan, the default is participation while for the employer provided plans we use for estimation the default is usually non-participation. Madrian and Shea (2001) examine how automatic enrollment increases participation rates. Our estimates will not account for this, but the selection effect we find indicates current non-covered workers may be more likely to opt out of a plan.
Furthermore, the estimate of the correlation between unobservables in the selection equation and those leading to participation equation is positive. Thus, individuals not offered a defined contribution plan will be less likely to participate than observably similar individuals who were offered a plan. Our estimates indicate that a policy extending matched tax-deferred saving plans, similar to defined contribution plans, to all low-income individuals would result in participation rates of 42 percent. Without controlling for selection that estimate is much higher, around 56 percent.\footnote{The 42 percent figure for low-income participation should be viewed as a lower bound on participation in the plan. As mentioned earlier, the purposed plan includes automatic enrollment which has been shown to increase participation. Our data does not include information on automatic enrollment. For example, see Madrian and Shea (2001).}

This chapter proceeds as follows. In section 1.2, we describe recent trends in pension offer rates and participation across income groups. In section 1.3 we discuss the econometric specification we use to determine the effect of different factors on pension participation. In section 1.4 we discuss results and in section 1.5 we conclude.

\section*{1.2 Trends in Pension Access and Participation}

Our interest, and the interest of policy makers, in the pension participation of low-income workers follows from the drop in pension participation for...
low-income workers that has accompanied the shift to voluntary DC pensions.

Pension participation is the result of two events: 1) access to a retirement plan, and 2) enrollment in a plan. Figure 1.1 shows the share of individuals working for an employer that sponsors a plan over the last three decades. Plan sponsorship clearly differs by earnings group. Only about one-third of individuals in the bottom third work for an employer that sponsors a plan, compared with over 70 percent for the highest earnings group.\(^8\) Overall, pension sponsorship has remained relatively stable.

Figure 1.1: Pension Sponsorship, all Private Sector Male Workers Age 25-64, by Earnings Tercile, 1979-2008

\[\text{Figure 1.1: Pension Sponsorship, all Private Sector Male Workers Age 25-64, by Earnings Tercile, 1979-2008}\]


In contrast, the participation rates for workers whose employers provide

\[^8\text{Earnings were defined as the reported monthly earnings on the first listed job.}\]
a plan have shown considerable divergence among earnings groups over time (see Figure 1.2). While workers in the top third have had a nearly constant participation rate over the past 25 years, the rate for the middle third declined considerably – from 94 to 86 percent – and for the lowest third fell sharply – from 85 to 69 percent. These drops could be the result of a number of factors, ranging from ineligibility to misinformation about the plans to an inability to contribute due to budget constraints.

Figure 1.2: Pension Participation Rate for Private Sector Male Workers Age 25-64 at Employers with Pensions, by Earnings Tercile, 1979-2008

![Figure 1.2: Pension Participation Rate for Private Sector Male Workers Age 25-64 at Employers with Pensions, by Earnings Tercile, 1979-2008](image)

Source: Authors’ calculations from 1980-2008 CPS.

The data on pension access and participation together determine the overall participation rate, as shown in Figure 1.3. The biggest drops in overall participation occurred among middle and low earners, where the rate fell by 22
and 29 percent, respectively. Decreasing participation rates among low earners at sponsoring employers is the main driver of the group’s overall decline in participation rather than any dramatic change in its’ access to pensions.

Figure 1.3: Pension Participation Rate for Private Sector Male Workers Age 25-64, by Earnings Tercile, 1979-2008

These figures illustrate the importance of understanding the relationship between pension participation and income. The participation rate of low-income workers has dropped not because employers are offering them plans with less frequency but because the plans they are being offered are increasingly voluntary. Indeed, low-income workers have a variety of reasons for choosing not to participate in an offered pension. The most frequent reason is their low-income itself. While defined benefit plans are funded through em-
ployer contributions that do not directly decrease a worker’s paycheck, participation in a defined contribution plan lowers a worker’s take home pay. Thus, low-income workers may be less willing to trade off today’s consumption for tomorrow’s than a similar high-income individual. Low-income workers may be less likely to participate for other reasons, including lack of knowledge about the benefits of participation or inability to take the steps to enroll. This is evident when examining figure 1.4, which shows that 27 percent of low-income workers voluntarily decline participation in offered defined contribution plans, with 16 percent doing so because of their low-income.9

Figure 1.4: Percent of Eligible Private Sector Male Workers Age 25-64 Declining Defined Contribution (DC) Plans, 2007

Source: Authors’ calculations from 2007 SIPP.

9An additional 33 percent of low income workers were ineligible for the offered defined contribution plan and thus did not voluntarily decline participation.
The concern of our study is that a voluntary non-participation rate of 27 percent should be viewed as a lower bound for low-income workers in general. Put another way, workers offered defined contribution plans may be the most likely to participate in such plans, having selected into a job that offers a mechanism for deferred compensation. If this is the case, policies aimed at providing voluntary savings plans amongst non-pensioned individuals would have lower participation rates than are seen in the pensioned population. In the next section, we present our empirical strategy for uncovering what determines pension participation.

1.3 Empirical Strategy

1.3.1 Data

We use data from the 1996, 2001, and 2004 panels of the Survey of Income and Program Participation (SIPP). In each panel of the SIPP, workers were asked a topical module entitled “Retirement Expectations and Pension Plan Coverage.” This topical module posed a series of questions on whether or not their present employer provided a pension, whether or not the individual participated in that pension, the type of pension the individual was offered, the individual’s contribution rate if the pension was a defined contribution
plan\textsuperscript{10} and whether the employer provides a matching contribution.\textsuperscript{11} This information, combined with the SIPP’s core information on an individual’s demographic characteristics and employer characteristics make the SIPP a good data set for estimating the relationships we have in mind.

For people offered a pension plan, we divide individuals into two categories: individuals offered a defined contribution plan and individuals offered a defined benefit plan. For workers who participated in their plan, individuals who claimed their benefit was based on earnings or years on the job are classified as defined benefit workers while workers who claimed they had an individual account plan are classified as defined contribution workers. If a worker chose not to participate in their plan a follow-up question asks if the plan they declined was a tax-deferred plan. If they answered “yes” to this question then they are classified as having been offered a defined contribution plan. Otherwise, we assume they were simply ineligible for an available defined benefit plan.\textsuperscript{12}

\textsuperscript{10}In practice, determining an individual’s contribution rate required examining a series of variables. Some individuals responded to a question on their percent of earnings contributed to the defined contribution pension. For these individuals, this rate was defined as their contribution rate. Some individuals did not answer this question but instead gave a contribution amount and frequency. This was used together with their income to determine a contribution rate.

\textsuperscript{11}In the 1996 panel, the “availability of employer match” question was not asked to non-participants in the DC plan. Instead, we imputed the missing values of the variable by using observations from the 2004 and 2007 panel and STATA’s hotdeck routine. Hotdeck stochastically imputes observations by matching individuals on user-specified variables. The ones that we used included firm size, industry, union status and the ratio of DC to DB plans in worker’s state. More info about “hotdeck” can be found at: http://ideas.repec.org/c/boc/bocode/s366901.html

\textsuperscript{12}In general, workers cannot decline participation in a defined benefit plan if they are eligible. Thus, we assume if they did not participate in an offered defined benefit plan that
Aside from pension plans, the core data of the SIPP provides information on individual and employer characteristics that are likely to be associated with pension offers and participation. This information includes an individual’s age, race, education, marital status, state of residence, and child status. The data also include an individual’s income from work and their net worth. On the employer side, the size of the worker’s employer, whether or not the employee is covered by a union, the worker’s tenure at their current firm, and the industry of employment were also obtained from the SIPP. Tables 1.1 through 1.4 present descriptive statistics of the workers in our sample. Table 1.1 examines pension coverage by type of plan across income groups. Overall 46 percent of the workers in our sample have access to a pension plan at their job.\footnote{About 26 percent of those plans are Defined Contribution and 20 percent are Defined Benefit. In addition, pension coverage increases by income terciles - 19.3 percent for the bottom income group compared with 69.7 percent for the top one.} About 26 percent of those plans are Defined Contribution and 20 percent are Defined Benefit. In addition, pension coverage increases by income terciles - 19.3 percent for the bottom income group compared with 69.7 percent for the top one.

Table 1.2 focuses on workers who have access to a defined contribution pension and examines their conditional contribution and participation rates. Among workers who are already with a firm that provides a DC type plan, they were ineligible for that plan.\footnote{Notice that this number is lower than what other studies usually report because our definition of “offered a pension plan” requires sponsorship on the part of the employer and worker eligibility. In that respect, workers who are currently not eligible to participate in the plan (for whatever reason) are classified as not being offered one. This definition is necessitated by the fact that in our estimation we want to explore the decision to voluntary participate in a plan - which is only viable if the worker is already eligible.}
79.7 percent choose to participate - 62.2 percent for those in the lowest income tercile, compared with 89 percent for those in the highest. Even though participation rates correlate highly with income, once we control for participation, contribution rates as a percent of salary do not seem to have a clear relationship with income. Among workers already participating (i.e. contributing a positive amount), the mean contribution rate is 7.4 percent; 8.8 percent for the bottom income tercile compared with 7.4 percent for the top income tercile.\textsuperscript{14}

Our intuition is that workers who are currently at DC sponsoring jobs are potentially different from those who are not, due to unobservable differences in tastes or constraints, which makes them more or less likely to participate in an offered DC plan. They are also different in terms of observable characteristics. Tables 1.3 and 1.4 compare how different these groups of workers are in terms of observable characteristics. Workers in our sample who have access to DC plans are older, more likely to be married, more likely to be white, and have more education than other workers. In addition, their mean annual income is about $15,000 higher and their net worth is $18,000 higher than that of workers who currently don’t have access to a DC plan.

\textsuperscript{14}We examined the 401(k) participation and contribution rates by income brackets as well, even though we did not include them in the paper. The results are largely consistent with previous literature that uses SIPP data. See for example Engen et al. (1994), Poterba et al. (1994) and Poterba et al. (1995). It should be noted that overall 401(k) eligibility and conditional participation rates are higher in our sample as compared to what those previous studies report. This could be due to the fact that we focus on individuals, rather than families and that our data comes from more recent panels of the SIPP when DC plans have already become the most popular type of employer-provided pensions.
likely to be male and married, are older, have more education and have longer tenure with their current employer compared with workers who choose to not participate. They also have higher income, wealth and net worth than the non-participating group. In addition, 87 percent of the participating workers have an employer match at the job, compared to 79 percent of those not participating. This is consistent with previous studies that find a positive link between the existence of employer match and the likelihood of participation.

Finally, we use the SIPP data and the respondents’ information as to type of pension plans available at the job, to also obtain information on the proportion across states of defined contribution versus all pension plans available to workers. This ratio differs by state and over time.\textsuperscript{15}

1.3.2 Modeling the Participation Decision

The goal of our empirical framework is to derive consistent estimates of the effect of income (and other factors) on DC participation. This will inform us as to what DC participation rates to expect as a result of a policy changes extending coverage. We also want to know how the policy effect will differ

\textsuperscript{15}As mentioned earlier, ideally we would like to have this information from the employer side directly. In previous specifications, we used data from the IRS Form 5500. The Form 5500 is a tax form filled out by employers who offer a pension plan. Importantly, the form asks for characteristics of the plan that can be used to determine whether a plan was defined benefit or defined contribution. The form also asks how many workers are covered by the plan and how many individuals work at the offering firm. However, because it is not clear how much bias the discrepancy between the employers’ reported state in the IRS form and the actual state of the firm’s operation adds to the estimation, we used the SIPP-derived variable for all of the estimation results reported in this chapter.
by income groups. In order to achieve these two goals we need an empirical specification which controls for the possible self-selection of workers into jobs with pension plans. Our hypothesis is that workers who are currently in DC sponsoring jobs differ systematically and in unobservable ways from workers not offered a DC plan. Failure to control for selection into jobs providing defined contribution plans will lead to parameter estimates of the decision to participate that do not apply to the average individual and will lead to biased conclusions in terms of policy effects.

The decision to participate in an offered 401(k) plan is discrete. Whether the worker is offered a 401(k) plan is also a discrete outcome. In addition, we want to allow the unobservable that affects the probability of being offered a 401(k) plan to be correlated with the unobservable that affects the worker’s decision to choose participation. The empirical setup that achieves both is a bivariate probit model with sample selection as described in Green (2008). This formulation was first presented by Van de Ven and Van Pragg (1981) and applied to our question of interest has the following basic set up:

\[ p_1 = \Pr[\text{Offered DC} = 1] = \Phi(z'\gamma) \]  
\[ p_2 = \Pr[\text{Participate} = 1|\text{Offered DC} = 1] = \Phi(x'\beta) \]

\[ (1.1) \]

\[ (1.2) \]
where

\[ x = \{ \text{demographics, tenure at current job, annual income, wealth, \ldots} \} \]

\[ z = \{ \text{demographics, annual income, wealth, union status, DC ratio by state, \ldots} \} \]

We make the usual assumption that the errors in the two equations have the standard normal distribution and \( \rho \) is a correlation parameter denoting the extent to which the two error co-vary. When \( \rho \neq 0 \), standard probit techniques applied to equation (1.2) yield biased results. To achieve consistent and asymptotically efficient estimate of \( \beta \) we need to account for the sample selection. In addition, for the model to be identified, the selection equation should have at least one variable that is excluded from the outcome equation. Otherwise, the model is identified only by functional form, and the coefficients have no structural interpretation. The exclusionary restriction should alter the probability an individual is offered a defined contribution pension plan but not the probability he participates in that plan. In our empirical specification union status and the proportion of defined contribution to all pension plans as offered by employers in the given state, serve as exclusionary restrictions. The identifying assumption is that workers do not move into states because they want a better/worse chance of being offered a defined contribution pension plan and that being at an union job affects one’s probability of having access to a 401(k) plan but not his propensity to save. We believe that both of these
assumptions are reasonable as long as they capture variation in the availability of 401(k) plans coming form the employer side and are exogenous factors in the workers’ saving decisions. On the other hand, one could argue that given enough time employers would respond to changes in the environment (such as the introduction of new government policy) and it would be no longer appropriate to assume such factors are exogenous. Because our empirical specification is not able to capture such dynamics, it is advisable to interpret the results as indicative of short-term rather than long-term effects of the policy.

1.3.3 Modeling the Contribution Rate

From a policy point of view it is interesting to determine what effect the extension of 401(k) plan availability will have on the contribution rates of people who decide to participate. In our second empirical specification we are interested in how much the employees chose to contribute to their 401(k) plans. Similarly to before, we need to control for sample selection. In addition, we need to take into account the fact that even though continuous, the outcome variable is censored from below at 0. This is due to the fact that workers cannot choose to contribute less than 0 percent. In the absence of censoring, it would have been appropriate to use the standard Heckman MLE or 2-step selection model. Ignoring the censoring, however, would lead to biased results.
Instead we refer to our approach as “censored regression with sample selection”. The participation equation is given by:

\[ p = \Pr[\text{Offered DC} = 1] = \Phi(z \gamma) \]

\[ z = \{\text{demographics, annual income, wealth, union status, DC ratio by state, ...} \} \]

while the structural equation takes the following form:

\[ Contribution \ Rate^* = x' \beta + \epsilon_2 \]

\[ Contribution \ Rate = \max(0, Contribution \ Rate^*) \text{ if Offered DC} = 1 \]

\[ Contribution \ Rate = . \text{ if Offered DC} = 0 \]

where

\[ x = \{\text{demographics, tenure at current job, annual income, wealth, ...} \} \]

\textit{Contribution Rate}^* is the worker’s desired contribution rate and \textit{Contribution Rate} is the one observed in the data, which is missing for individuals not offered a 401(k) plan. We make the standard assumption of homoskedasticity and joint normality of the errors in the two equations, where \( \rho \) denotes the correlation coefficient. We use the same exclusionary restriction as in the previous specification. The model is estimated via maximum likelihood.\(^{16}\) Table 1.8 compares results achieved by running a regression on the contribution rate.

\(^{16}\)We do the maximum likelihood estimation using STATA “cmp” routine – an estimation routine that accommodates a variety of conditional mixed processes. For more information on “cmp” see Roodman (2007) and Roodman (2009).
ignoring selection, a censored regression model, and a selection model with censoring.

1.4 Results

1.4.1 Participation Decision

Table 1.5 compares estimation of a probit model on participation without controlling for selection and while controlling for selection, the “Heckman Probit.” The right hand column provides the estimates of the selection equation.

The results of the probit and the probit with selection are largely consistent with the literature with respect to sign and significance. Similarly to previous studies,\textsuperscript{17} we find that individuals who are married, well educated, have high tenure at their firm, and work at firms with a employer match\textsuperscript{18} are all more likely to participate than others. Blacks and younger individuals are

\textsuperscript{17}See for example Munnell et al. (2009) and Bassett et al. (1998).

\textsuperscript{18}Most previous studies find that employees respond positively to the existence of an employer match. Munnell et al. (2009) find a significant positive effect of the employer match on contribution rates, although the relationship is concave with respect to the size of the match. Similarly, Bassett et al. (1998) find that workers with employer matches are more likely to participate in 401(k) plans than workers without such matches. No evidence is found that the level of the employer match has a positive impact on employee participation, however. Kusko et al. (1998) found little change in either participation or contributions in response to large changes over time in matching provisions. Papke (1995) showed that participation increases with the level of the match rate, with smaller marginal effects at higher match rates, and that contributions increase markedly as the employer moves from a zero to a positive match rate, with a negative effect at very high match rates. Papke and Poterba (1995) concluded that participation increases with the match rate but found no significant effect on contributions. Clark and Schieber (1998) found a positive effect of the match rate on both participation and contributions, but their sample contained no firms without a match rate.
less likely to participate. Also consistent with expectations, individuals with high net worth and high-income are more likely to participate in an offered defined contribution plan than other individuals.

These results are not in any way surprising - previous literature has already documented similar (in terms of direction and significance) relationships between the independent variables and 401(k) plan participation. What is interesting is the change in the magnitudes of the effects once we control for selection.

Our intuition led us to two testable implications: (1) workers’ selection on unobservables into defined contribution jobs is positively correlated with unobservables related to participation; and (2) the effect of income on participation without controlling for selection will be underestimated. The estimates suggest these implications hold in the data. The estimated correlation between unobservables in the outcome and participation equations is .251. A likelihood ratio test shows this correlation is significantly different from 0. This suggests individuals in defined contribution jobs are more likely to participate than similar individuals in jobs not offering these pension plans. The effect of income is also smaller in the equation estimated without controls for selection. In the simple probit model the marginal effect of log income on pension participation is 6.7 percent, when controlling for selection it is 11.9 percent. This shows us that in the population low-income workers are much
less likely than high-income workers to participate in a defined contribution type pension plan. However, in the selected sample this difference is mitigated by selection into the plan. If one is to predict the effect of policies targeted at the whole population but ignores the selection effect, he is likely to understate the importance of income and the disparity of the policy effect among income groups.

Let us illustrate this point with the recently proposed government plan to extend DC-type coverage to workers not currently covered by a plan. Our estimates indicate that the predicted participation rate for this population taken from the current literature would be an overestimate. Tables 1.6 and 1.7 indicate the size and magnitude of this overestimation under two different assumptions: (1) all defined contribution plans offer a match (employer and government) at the same rate as the average firm in our sample, and (2) none of the defined contribution plans provide a match.\(^{19}\)

Table 1.6 indicates that if matched defined contribution plans were provided to all individuals a standard probit would suggest that 74.5 percent of individuals would participate.\(^{20}\) This number is lower than the percent that participate in actual offered plans only because of observable differences between those offered and those not offered a defined contribution pension. Once

\(^{19}\)In President Obama’s 2010 State of the Union Address the plans were proposed to be similar to IRAs and thus would not provide a match.

\(^{20}\)The differences discussed below are similar if the plans are not matched. These differences can be calculated from table 1.7.
controlling for selection, the predicted participation rate drops to 65.0 percent. This drop occurs because the group of people not already offered plans is substantially less likely to participate based on unobserved characteristics. This factor is not captured by the probit alone. If we examine the low-income group, the group commonly associated with the extension of defined contribution plans, we see an even larger difference. Under the probit estimation, 56.0 percent of individuals in the lower tercile of the income distribution would participate if all were offered a defined contribution pension plan. Once controlling for selection, this drops to 42.4 percent, a drop of 13.6 percentage points. In addition, the difference is larger for low-income individuals than individuals in the middle and higher terciles. For those groups the difference is 9.9 and 5.5 percentage points respectively. Ignoring selection seems to have especially large ramifications for low-income workers, the group most likely to be affected by any potential effort to expand coverage. In addition, ignoring selection would make us expect a smaller gap in participation rates between low and high-income groups. Specifically, the probit model would suggest a difference of 32.4 percentage points in participation rates after the expansion of the policy. In contrast, when controlling for selection one would expect a much higher pension inequality of 40.5 percentage points.
1.4.2 Contribution Decision

Our second model uses information on contribution rates instead of on participation. In this model, an individual offered a defined contribution plan participated if they contributed greater than 0 percent of their income. If they contributed nothing, then they were classified as a non-participant. Thus, the contribution rate is a censored dependent variable that is the result of selection into a defined contribution job. The results are presented in table 1.8. The results from a simple OLS, a censored regression, and a selection model with censoring are included in the table.

The results in table 1.8 are largely consistent with the results of the participation model. An individual’s age, the existence of an employer match, and a higher level of education are all associated with higher contribution rates. On the other hand, children and being black are associated with lower contribution rates. Individuals with higher income and with higher net worth have higher contribution rates than others. As in the previous model, the effect of income is underestimated in the equations not controlling for selection. In the OLS estimation, the effect of log income is actually negative and significant, while in the censored model and the censored model with selection it is positive, although imprecisely estimated. The analysis of the contribution rates confirms the analysis of the participation equations: there is positive selection into defined contribution jobs and ignoring this selection leads to underesti-
mation of the effect of income on pension participation. It also provides some insight on contribution rates should defined contribution plans be extended to more individuals. Controlling for selection in the participation equation revealed that basing estimates of expected participation rates on those currently offered pensions will overestimate the overall participation rate. A similar result holds for pension contribution rates, as can be seen in tables 1.9 and 1.10. We will focus on estimates based on the assumption that all defined contribution plans, including those provided by the government, are matched at the average rate. The standard regression predicts that the average participating individual from the population would contribute 5.4 percent of their income to their defined contribution plan. After controlling for censoring and selection, the contribution percentage drops to 4.3 percent. This decline is of similar magnitude across income groups.\textsuperscript{21}

The results from the participation and contribution equations suggest that ignoring selection will have two effects: (1) it will overestimate the participation rate and overestimate it the most for low-income workers; and (2) it will overestimate contribution rates similarly for all income groups. The implication of these results should be considered when making policies that extend defined contribution plans to low-income individuals. The estimates

\textsuperscript{21}The censored model with selection yielded a percent participating that was likely too high. About 85 percent of individuals had a positive predicted contribution rate above 0 percent, which is well above 57.5 percent suggested by the probit. A possible explanation could be the existence of severe measurement error in the contribution rate variable.
suggest both participation rates and contribution rates will be lower than is suggested by the current literature.

1.5 Conclusion

As defined contribution plans have expanded over the last three decades, pension participation amongst low-income individuals has fallen more than for any other group. This decline has been driven by the voluntary decision of many low-income individuals to decline participation in offered pension plans. This decline, combined with perceived future decreases in Social Security’s generosity, have led many to believe extending tax-deferred savings plans to low-income individuals is a way to ensure them an acceptable retirement income. Given that 60 percent of eligible low-income workers offered a defined contribution pension participate in the plan, on the surface at least, this seems like an effective strategy. Our analysis suggests this picture may be too optimistic.

Our intuition suggested, and our estimation confirms, that workers may select into defined contribution jobs based on some unobserved propensity to participate in the plan. The implication of this selection is that individuals not currently at jobs offering defined contribution plans may be especially unlikely to contribute to a tax-deferred savings plan. This may be especially true of the low-income population for whom the selection effect may be strong.
Our estimates suggest that the selection effect is non-trivial. Controlling for selection leads to the prediction that only 42 percent of individuals in the lower income tercile are likely to participate in an offered tax-deferred savings plan. Those who do participate are likely to contribute 3.1 percent of their income to the plan. Offering these kinds of savings vehicles to individuals not covered by a pension plan may be helpful to those who participate. However, by controlling for the selection of workers into pensioned jobs we believe our estimates show that fewer individuals will participate than policymakers might hope.
5500-CRR Data, Panel of Current and Usable Form 5500 Data, Center for Retirement Research at Boston College, Chestnut Hill, MA.


Table 1.1: Percent of Workers with Pension Coverage by Type of Plan and by Income

<table>
<thead>
<tr>
<th></th>
<th>Offered a Pension*</th>
<th>DC type</th>
<th>DB type</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>46.0%</td>
<td>25.9%</td>
<td>20.1%</td>
</tr>
<tr>
<td>Bottom Income Tercile</td>
<td>19.3%</td>
<td>11.0%</td>
<td>8.3%</td>
</tr>
<tr>
<td>Middle Income Tercile</td>
<td>49.0%</td>
<td>28.5%</td>
<td>20.5%</td>
</tr>
<tr>
<td>Top Income Tercile</td>
<td>69.7%</td>
<td>38.3%</td>
<td>31.4%</td>
</tr>
</tbody>
</table>

* Where “offered a pension” means the worker is with an employer who sponsors a pension plan and the worker is eligible to participate.

Source: Authors’ calculations, based on data from the Survey of Income and Program Participation.

Table 1.2: 401(k) Sponsorship, Participation and Contribution Rates by Income

<table>
<thead>
<tr>
<th></th>
<th>DC Sponsorship Rate</th>
<th>Conditional Participation Rate</th>
<th>Conditional Contribution Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>25.9%</td>
<td>79.7%</td>
<td>7.4%</td>
</tr>
<tr>
<td>Bottom Income Tercile</td>
<td>11.0%</td>
<td>62.2%</td>
<td>8.8%</td>
</tr>
<tr>
<td>Middle Income Tercile</td>
<td>28.5%</td>
<td>74.0%</td>
<td>6.9%</td>
</tr>
<tr>
<td>Top Income Tercile</td>
<td>38.3%</td>
<td>89.0%</td>
<td>7.4%</td>
</tr>
</tbody>
</table>

Source: Authors’ calculations, based on data from the Survey of Income and Program Participation.
Table 1.3: Characteristics of Workers by 401(k) Sponsorship

<table>
<thead>
<tr>
<th>Variable</th>
<th>Not Offered DC</th>
<th>Offered DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>48.8%</td>
<td>46.6%</td>
</tr>
<tr>
<td>% Married</td>
<td>52.3%</td>
<td>63.1%</td>
</tr>
<tr>
<td>% with Children</td>
<td>44.3%</td>
<td>43.9%</td>
</tr>
<tr>
<td>% White</td>
<td>82.7%</td>
<td>85.9%</td>
</tr>
<tr>
<td>% Black</td>
<td>11.6%</td>
<td>8.5%</td>
</tr>
<tr>
<td>Age</td>
<td>37.4</td>
<td>40.3</td>
</tr>
<tr>
<td>Years of Education</td>
<td>12.9</td>
<td>13.8</td>
</tr>
<tr>
<td>Tenure</td>
<td>6.1</td>
<td>7.7</td>
</tr>
<tr>
<td>Mean Income</td>
<td>$28,522</td>
<td>$43,783</td>
</tr>
<tr>
<td>Mean Wealth</td>
<td>$157,167</td>
<td>$176,621</td>
</tr>
<tr>
<td>Mean Net Worth</td>
<td>$148,434</td>
<td>$166,831</td>
</tr>
</tbody>
</table>

Source: Authors’ calculations, based on data from the Survey of Income and Program Participation.
Table 1.4: Characteristics of Workers Offered 401(k) Plans by Participation Status

<table>
<thead>
<tr>
<th>Variable</th>
<th>Do Not Participate</th>
<th>Participate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>53.8%</td>
<td>44.7%</td>
</tr>
<tr>
<td>% Married</td>
<td>49.5%</td>
<td>66.6%</td>
</tr>
<tr>
<td>% with Children</td>
<td>43.6%</td>
<td>43.9%</td>
</tr>
<tr>
<td>% White</td>
<td>80.1%</td>
<td>87.4%</td>
</tr>
<tr>
<td>% Black</td>
<td>13.7%</td>
<td>7.2%</td>
</tr>
<tr>
<td>Age</td>
<td>36.5</td>
<td>41.2</td>
</tr>
<tr>
<td>Years of Education</td>
<td>13.1</td>
<td>14.0</td>
</tr>
<tr>
<td>Tenure</td>
<td>4.3</td>
<td>8.5</td>
</tr>
<tr>
<td>Mean Income</td>
<td>$28,769</td>
<td>$47,609</td>
</tr>
<tr>
<td>Mean Wealth</td>
<td>$102,333</td>
<td>$195,552</td>
</tr>
<tr>
<td>Mean Net Worth</td>
<td>$92,620</td>
<td>$185,741</td>
</tr>
<tr>
<td>Employer Provides a Match</td>
<td>79.0%</td>
<td>87.1%</td>
</tr>
</tbody>
</table>

Source: Authors’ calculations, based on data from the Survey of Income and Program Participation.
Table 1.5: 401(k) Participation Models

<table>
<thead>
<tr>
<th>Variable</th>
<th>Probit Coeff</th>
<th>SE</th>
<th>Prob</th>
<th>Probit Sel. Coeff</th>
<th>SE</th>
<th>Prob</th>
<th>Outcome Sel. Coeff</th>
<th>SE</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>-0.069**</td>
<td>0.023</td>
<td>-0.017**</td>
<td>-0.050</td>
<td>0.023</td>
<td>-0.018*</td>
<td>-0.068**</td>
<td>0.011</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.119**</td>
<td>0.032</td>
<td>0.029**</td>
<td>0.171**</td>
<td>0.033</td>
<td>0.063**</td>
<td>0.288**</td>
<td>0.014</td>
<td></td>
</tr>
<tr>
<td>Age²</td>
<td>-0.002**</td>
<td>0.001</td>
<td>-0.001**</td>
<td>-0.003**</td>
<td>0.001</td>
<td>-0.001**</td>
<td>-0.007**</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>0.060</td>
<td>0.046</td>
<td>0.015</td>
<td>0.066</td>
<td>0.045</td>
<td>0.025</td>
<td>0.059**</td>
<td>0.023</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>-0.147*</td>
<td>0.057</td>
<td>-0.038*</td>
<td>-0.158**</td>
<td>0.055</td>
<td>-0.059**</td>
<td>-0.059**</td>
<td>0.028</td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>0.112**</td>
<td>0.025</td>
<td>0.028**</td>
<td>0.112**</td>
<td>0.025</td>
<td>0.041**</td>
<td>0.012</td>
<td>0.013</td>
<td></td>
</tr>
<tr>
<td>Has kids</td>
<td>-0.042</td>
<td>0.025</td>
<td>-0.010</td>
<td>-0.050*</td>
<td>0.025</td>
<td>-0.018*</td>
<td>-0.042**</td>
<td>0.012</td>
<td></td>
</tr>
<tr>
<td>Years educ</td>
<td>0.046**</td>
<td>0.005</td>
<td>0.011**</td>
<td>0.048**</td>
<td>0.005</td>
<td>0.018**</td>
<td>0.015**</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>Tenure</td>
<td>0.040**</td>
<td>0.002</td>
<td>0.010**</td>
<td>0.038**</td>
<td>0.002</td>
<td>0.014**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DB at old job</td>
<td>0.039</td>
<td>0.064</td>
<td>0.010</td>
<td>0.056</td>
<td>0.063</td>
<td>0.020</td>
<td>0.085**</td>
<td>0.030</td>
<td></td>
</tr>
<tr>
<td>DC at old job</td>
<td>0.008</td>
<td>0.053</td>
<td>0.002</td>
<td>0.050</td>
<td>0.053</td>
<td>0.018</td>
<td>0.230**</td>
<td>0.028</td>
<td></td>
</tr>
<tr>
<td>Provides match</td>
<td>0.406**</td>
<td>0.029</td>
<td>0.106**</td>
<td>0.405**</td>
<td>0.028</td>
<td>0.149**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log Networth</td>
<td>0.075**</td>
<td>0.006</td>
<td>0.019**</td>
<td>0.076**</td>
<td>0.006</td>
<td>0.029**</td>
<td>0.015**</td>
<td>0.003</td>
<td></td>
</tr>
<tr>
<td>Year 2004</td>
<td>-0.013</td>
<td>0.030</td>
<td>-0.002</td>
<td>0.003</td>
<td>0.030</td>
<td>0.001</td>
<td>0.059**</td>
<td>0.014</td>
<td></td>
</tr>
<tr>
<td>Year 2007</td>
<td>-0.243**</td>
<td>0.027</td>
<td>-0.061**</td>
<td>-0.227**</td>
<td>0.027</td>
<td>-0.084**</td>
<td>-0.059**</td>
<td>0.014</td>
<td></td>
</tr>
<tr>
<td>Log Income</td>
<td>0.274**</td>
<td>0.018</td>
<td>0.067**</td>
<td>0.324**</td>
<td>0.020</td>
<td>0.119**</td>
<td>0.278**</td>
<td>0.008</td>
<td></td>
</tr>
<tr>
<td>DC ratio</td>
<td></td>
<td></td>
<td></td>
<td>1.952**</td>
<td>0.079</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Union Status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.210**</td>
<td>0.18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ρ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.251</td>
<td>0.053</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

LR test of indep. eqns. (ρ = 0): \( \chi^2(1) = 19.99 \) Prob > \( \chi^2 = 0.0000 \)

N uncensored 19,582
N censored 19,582
N all 73,523

* Significantly different from 0 at .05 level.
** Significantly different from 0 at .01 level.

Source: Authors’ calculations, based on data from the Survey of Income and Program Participation.
Table 1.6: Predicted Probabilities of Participation in 401(k) if All 401(k) Plans Provide and Employer Match

<table>
<thead>
<tr>
<th></th>
<th>Probit</th>
<th>Probit with Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>74.5%</td>
<td>65.0%</td>
</tr>
<tr>
<td>Bottom Income Tercile</td>
<td>56.0%</td>
<td>42.4%</td>
</tr>
<tr>
<td>Middle Income Tercile</td>
<td>75.6%</td>
<td>65.7%</td>
</tr>
<tr>
<td>Top Income Tercile</td>
<td>88.4%</td>
<td>82.9%</td>
</tr>
</tbody>
</table>

Source: Authors’ calculations, based on data from the Survey of Income and Program Participation.

Table 1.7: Predicted Probabilities of Participation in 401(k) if No 401(k) Plans Provide an Employer Match

<table>
<thead>
<tr>
<th></th>
<th>Probit</th>
<th>Probit with Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>64.7%</td>
<td>52.5%</td>
</tr>
<tr>
<td>Bottom Income Tercile</td>
<td>41.8%</td>
<td>29.4%</td>
</tr>
<tr>
<td>Middle Income Tercile</td>
<td>62.8%</td>
<td>51.4%</td>
</tr>
<tr>
<td>Top Income Tercile</td>
<td>79.7%</td>
<td>72.2%</td>
</tr>
</tbody>
</table>

Source: Authors’ calculations, based on data from the Survey of Income and Program Participation.
Table 1.8: 401(k) Contribution Rate Models

<table>
<thead>
<tr>
<th>Variable</th>
<th>Least Squares</th>
<th>Censored Regression</th>
<th>Censored Regression with Sample Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coeff</td>
<td>SE</td>
<td>Coeff</td>
</tr>
<tr>
<td>Female</td>
<td>-.616**</td>
<td>.093</td>
<td>-.703**</td>
</tr>
<tr>
<td>Age</td>
<td>.557**</td>
<td>.138</td>
<td>1.338**</td>
</tr>
<tr>
<td>Age²</td>
<td>-.011**</td>
<td>.003</td>
<td>-.028**</td>
</tr>
<tr>
<td>White</td>
<td>-.054</td>
<td>.191</td>
<td>-.024</td>
</tr>
<tr>
<td>Black</td>
<td>-.885**</td>
<td>.240</td>
<td>-1.311**</td>
</tr>
<tr>
<td>Married</td>
<td>.521**</td>
<td>.105</td>
<td>.733**</td>
</tr>
<tr>
<td>Has kids</td>
<td>-.664**</td>
<td>.102</td>
<td>-.925**</td>
</tr>
<tr>
<td>Years educ</td>
<td>.227**</td>
<td>.021</td>
<td>.278**</td>
</tr>
<tr>
<td>Tenure</td>
<td>.070**</td>
<td>.007</td>
<td>.106**</td>
</tr>
<tr>
<td>DB at old job</td>
<td>.075</td>
<td>.241</td>
<td>.086</td>
</tr>
<tr>
<td>DC at old job</td>
<td>.524**</td>
<td>.205</td>
<td>.621*</td>
</tr>
<tr>
<td>Provides match</td>
<td>.727**</td>
<td>.124</td>
<td>1.419**</td>
</tr>
<tr>
<td>Log Networth</td>
<td>.354**</td>
<td>.025</td>
<td>.530**</td>
</tr>
<tr>
<td>Year 2004</td>
<td>.074</td>
<td>.118</td>
<td>.091</td>
</tr>
<tr>
<td>Year 2007</td>
<td>-.703**</td>
<td>.111</td>
<td>-1.118**</td>
</tr>
<tr>
<td>Log Income</td>
<td>-.302**</td>
<td>.077</td>
<td>.193</td>
</tr>
<tr>
<td>DC ratio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Union Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\rho$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N uncensored</td>
<td>12,757</td>
<td></td>
<td>12,757</td>
</tr>
<tr>
<td>N left-censored</td>
<td>3,941</td>
<td></td>
<td>3,941</td>
</tr>
<tr>
<td>N all</td>
<td>16,698</td>
<td></td>
<td>16,698</td>
</tr>
</tbody>
</table>

* Significantly different from 0 at .05 level.

** Significantly different from 0 at .01 level.

Source: Authors’ calculations, based on data from the Survey of Income and Program Participation.
Table 1.9: Predicted Conditional Contribution Rates* in 401(k) plans if All 401(k) Plans Provide an Employer Match

<table>
<thead>
<tr>
<th></th>
<th>Least Squares</th>
<th>Censored Regression</th>
<th>Censored Regression with Sample Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>5.36%</td>
<td>4.59%</td>
<td>4.31%</td>
</tr>
<tr>
<td>Bottom Income Tercile</td>
<td>4.42%</td>
<td>3.30%</td>
<td>3.06%</td>
</tr>
<tr>
<td>Middle Income Tercile</td>
<td>5.20%</td>
<td>4.13%</td>
<td>3.80%</td>
</tr>
<tr>
<td>Top Income Tercile</td>
<td>6.27%</td>
<td>5.79%</td>
<td>5.46%</td>
</tr>
</tbody>
</table>

* Mean percent of salary contributed to 401(k) plan for workers participating in the plan. Source: Authors’ calculations, based on data from the Survey of Income and Program Participation.

Table 1.10: Predicted Conditional Contribution Rates* in 401(k) plans if No 401(k) Plans Provide an Employer Match

<table>
<thead>
<tr>
<th></th>
<th>Least Squares</th>
<th>Censored Regression</th>
<th>Censored Regression with Sample Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>4.67%</td>
<td>3.60%</td>
<td>3.28%</td>
</tr>
<tr>
<td>Bottom Income Tercile</td>
<td>3.77%</td>
<td>2.59%</td>
<td>2.32%</td>
</tr>
<tr>
<td>Middle Income Tercile</td>
<td>4.50%</td>
<td>3.11%</td>
<td>2.75%</td>
</tr>
<tr>
<td>Top Income Tercile</td>
<td>5.55%</td>
<td>4.50%</td>
<td>4.11%</td>
</tr>
</tbody>
</table>

* Mean percent of salary contributed to 401(k) plan for workers participating in the plan. Source: Authors’ calculations, based on data from the Survey of Income and Program Participation.
Chapter 2

Private Pensions and Wealth Accumulation in a Dynamic Model of Job Search and Savings

2.1 Introduction

Standard labor theory suggests that workers self-select into jobs that offer a mix of wage and non-wage benefits that best matches their preferences (see, for example; Woodbury 1983). Moreover, the theory of equalizing differences implies that otherwise identical employees, who receive higher non-wage benefits will be paid a lower wage (Rosen 1987). Thus, controlling for productivity and other characteristics affecting wages, one should expect to find a negative relationship between the wage and non-wage components of compensation packages.

However, the empirical evidence on the existence of a compensating
wage differential for pension benefits has been mixed. The results range from a significant negative to a significant positive relationship between wages and pensions.\textsuperscript{1} Most of the studies that address this question estimate the wage-pension trade-off using a hedonic pension-earnings equation.\textsuperscript{2} Typically such models have an earnings measure as a dependent variable and pension accruals or promised benefits on the right-hand side. Thus, the lack of strong evidence for a trade-off might be due to the implicit assumption that pension benefits are exogenous.

Treating pensions as exogenous would fail to recognize that workers’ job search behavior determines simultaneously their wage and pension benefits. Currently in the US not all employers offer pensions, and of those that do, most offer just one pension plan.\textsuperscript{3} So, the worker cannot decide whether to enroll in a pension plan nor what type of plan to have; he can only choose his employer and enroll in the plan that it offers. In that respect, any job acceptance decision is intertwined with the saving for retirement decision. When deciding between job offers, the worker has to take into account how each offer will affect his consumption today versus his ability to save for the future. An observed positive correlation between wages and pensions could be simply


\textsuperscript{2}See a survey paper by Gustman et al. (1994).

\textsuperscript{3}Decressin et al. (2005).
due to the fact that more productive workers, who would also receive higher wages, are the ones who are more risk averse and prefer to save through an employer-provided channel. They consciously choose to work for employers who offer pensions and thus end up with both a high wage and high pension assets. Ignoring such type of unobserved selection would not only lead to biased estimates when testing for the existence of a compensating differential but would also prevent us from making reliable predictions on how changes in the distribution or type of compensation packages would affect workers’ employment and retirement saving outcomes.

By modeling the trade-off that workers face when choosing between compensation in the form of wages versus pension benefits, and by tracing out the sorting mechanism that leads to the observed positive correlation between wages and pensions in the data, this paper not only provides an implicit test for the existence of a compensating differential but also provides a framework within which we can assess the effect of counterfactual and policy experiments. The question of interest is how will policies that change the distribution or incentives of pension plans affect pension coverage and savings for retirement?

This is a policy relevant question, given the recent changes in the types of pension plans being offered to the worker. Employer-provided pension plans have traditionally been an important component of workers’ compensation in the US.\(^4\) The type of pension coverage, however, has changed dramatically.\(^4\)

\(^4\)For the past six decades, employer-provided pensions have been an important part of
Pensions have shifted from traditional defined benefit (DB) plans to the now dominant defined contribution (DC) plans. The new type of plans have introduced new risks and incentives for retirement saving. While these plans have the potential to provide substantial retirement income, in practice most participants have only modest account balances – a trend which has lead to increased concern about workers’ preparedness for retirement and has stimulated debate on what kind of policies would encourage workers to save more.

In this paper I suggest a new approach for addressing these questions, which recognizes that the wage versus pension benefit decision is crucially related to the job search and saving for retirement decision. I construct a life cycle model in which individuals search for jobs, consume, and save on their own and through their employer-provided pension in order to maximize utility. Job offers are wage-pension packages, consisting of a wage component, and a pension plan – DB, DC or no plan. Whenever the worker decides whether to accept or reject a job offer he has to consider the trade-off between the wage and pension components of that offer and how it compares with his other alternatives. His decision will be the result of interplay between his

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5For comparison in 1980, of all workers with pension coverage, only 40 percent had a DC plan while 83 percent had a DB plan. In 2004, those numbers changed to 89 percent and 39 percent, respectively (Munnell and Perun 2006).

6Munnell and Perun (2006)

7Defined benefit and defined contribution are currently the two major types of private pension plans in the US (see Munnell and Perun 2006).
preferences and the set of incentives and risks that each pension plan comes with. Thus both wages and pensions are determined endogenously by the worker’s job search process.

The model is designed to capture the main differences between the two types of plans, as well as to account for the following stylized facts: 1) Positive cross-sectional correlation between wages and pensions; pension coverage and participation is more prevalent among high earners. 8 2) Higher job mobility among workers with DC plans, compared to those with DB plans. 9

Consistent with the structure of private pension plans in the US, the DB plan guarantees a lifetime income stream which is based on tenure and pre-retirement earnings. In contrast, in the DC plan, the worker makes elective contributions to an account in which assets accumulate over time. The employer also provides a matching contribution.

Three basic routes affect the way the worker substitutes between the wage and pension components of job offers. These are: 1) generosity of the plan; 2) uncertainty in rates of return; 3) tax incentives.

In an environment with no rate of return uncertainty, depending on the generosity of the DB benefits and the match and contribution rates in the DC plan, there exist equivalent wages which make the worker indifferent between

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8Pension coverage is much more extensive for high-income households compared to the low-income ones – around 85 percent of the households in the top two quintiles of the income distribution have pensions, compared with a mere 28 percent for the bottom quintile (Munnell and Perum 2006).

9See Munnell et al. (2006).
choosing any of the three types of jobs. A no-pension but higher-wage job could offer just as much expected lifetime utility as a DB or a DC-type job with a lower wage. While in DB plans, the generosity is determined by the benefit formula, in DC plans it depends on the availability of an employer match.\(^\text{10}\)

Of course, this trade-off will not be the same for different workers. While DC plans are easily portable across employers, DB plans are not. Combined with the back-loaded nature of benefit accrual in DB plans, these plans are more advantageous to workers who do not expect to change jobs often, or who have already accumulated many years of tenure with their employer. Such workers will be willing to trade-off even more in terms of current wages for the availability of a DB plan. Thus we should expect to see that on average older workers, as well as less mobile workers are more likely to have DB-type plans as compared with DC-type plans or no pension plans. Consequently, the model accommodates various forms of observed heterogeneity in order to allow for differences in expected future offers and career paths to influence the wage-pension and saving decisions.

Uncertainty in the rate of return adds an additional trade-off. In contrast to the DB plan which guarantees a specific benefit, the worker bears all the investment risk on his DC and personal savings accounts. Thus, the more

\(^{10}\)Because the worker is allowed to choose whether to contribute or not to his DC plan, for the same wage and rate of return on assets, he would be indifferent between accepting the DC-job or a no-pension job. The existence of an employer match, however, would make the worker willing to trade-off a lower current wage for the DC-type job.
risk averse the individual, the more willing he will be to substitute today’s wages for tomorrow’s secure pension income and the more likely he will be to accept a DB-type job.\textsuperscript{11} To capture this additional channel of workers’ behavior, the model allows for the existence of unobserved heterogeneity in preferences, stemming from differences in risk aversion.

Tax incentives also add to the appeal of pension plans. Both employee’s and employer’s contributions to DC plans are made out of pre-tax dollars. Thus, for the same wage and rate of return on assets, tax incentives would make the DC-type job preferable even in the absence of an employer match. Moreover, the delayed taxation of pension benefits makes both DC and DB-type jobs even more appealing as compared with the no-pension offers; due to the progressive nature of the income tax law, even more so for high-wage earners. In other words, the tax deferral on pension contributions and delayed taxation of pension benefits would make workers willing to accept even lower current wages for the availability of a DC or a DB-type of plan.

The model is estimated on the Panel Study of Income Dynamics (PSID) data via the method of indirect inference. The results provide no evidence for the existence of a compensating differential – the estimates indicate positive correlation between wages and pensions in the compensation packages that employers offer even after controlling for unobservable selection on the part of

\textsuperscript{11}In the model and estimation I have assumed the same rate of return on both DC and non-pension assets. Thus, uncertainty in the rate of return does not add any additional trade-offs between the no-pension and DC-type of job.
the workers. The estimated structural parameters are used to address a set of policy experiments: 1) A policy change which makes contributions to DC plans mandatory for all workers with DC-type jobs results in a lower overall pension coverage but an increase in average DC balance accumulations which more than compensate the decrease in average non-pension savings. As a result, workers approach retirement on average with as much as 10 percent more overall assets. 2) A complete phaseout of DB plans from the job-offer distribution leads to higher overall DC accumulations but lower overall savings for retirement. 3) Eliminating the tax incentives on pension contributions leads to lower pension coverage and lower DC accumulations, which are not fully offset by an increase in non-pension savings.

The remainder of this chapter is organized as follows. Related literature is reviewed next. Section 2.2 presents the dynamic job search model and the solution approach. The main features of the data are presented in section 2.3. Section 2.4 discusses the estimation procedure. Section 2.5 presents the results. Section 2.6 discusses policy experiments. Section 2.7 concludes.

2.1.1 Related Literature

This paper is related to two quite different strands of literature in labor economics. On one hand, by modeling job offers as compensation packages, this paper fits within the literature on search models that include job characteristics
other than the offered wage. Some of the recent work in this field includes Blau (1991) and Bloemen (2008), in which jobs are characterized by a combination of a wage and number of working hours, and Dey and Flinn (2005); who focus on wage and employer-provided health insurance. Similar to those papers, this study models the job search decision in a structural dynamic framework following workers’ job decisions over time. To the best of my knowledge, this paper is the first one to consider job offers as wage-pension packages and thus contributes to the existing literature from a methodological standpoint.

On the other hand, this study is related to the growing literature that studies retirement behavior, where dynamic discrete choice models have already seen numerous applications. Many authors have found the dynamic modeling approach useful for explaining the consumption and employment behavior of older workers – Gustman and Steinmeier (1986), Blau (2008), Van der Klaauw and Wolpin (2008). This paper uses a similar theoretical framework to model the saving for retirement decision and the job choice and employment decisions of workers at younger ages.

Finally, this chapter studies workers’ behavior when choosing between jobs offering defined benefit plan versus those offering defined contribution plan. As such, it falls among the broader literature on the benefits and risks of DB and DC plans. Many studies in this area have already documented a link between increased job mobility and the growing popularity of DC plans.
Other papers have made comparisons of simulated retirement wealth under DB and DC – Poterba et al. (2007), Samwick and Skinner (2006), and Schrager (2009). This paper contributes to the understanding of the links between job mobility, type of plan and retirement wealth by estimating a behavioral model and performing counterfactual experiments on how changes in the pension offer distribution affect job mobility and the distribution of retirement wealth.

2.2 Model

This section describes a dynamic stochastic model of employment and savings decisions of an unmarried individual from a point in his life cycle when he is first observed in the data to the end of the life cycle. Initial conditions are those that exist at the time the individual is first observed and are addressed in the solution and estimation sections.

2.2.1 Choice Set

The agent lives until age $A^T$ and is allowed to work till age $A^R - 1$. From the time he reaches age $A^R$ till $A^T$, he is retired. During his working life, at each discrete age $a$, the agent chooses consumption $C_a$, employment status $H_a$ ($H_a = 1$ if employed and $H_a = 0$ if unemployed). If the agent works for an employer that offers a DC plan, he has the discrete choice whether to

\[^{12}\text{In the estimation, } A^T = 80 \text{ and } A^R = 66.\]
contribute or not to that plan ($d_a = 1$ if he contributes, $d_a = 0$ if otherwise).

If at age $a - 1$ the agent was employed, there is an exogenous probability $\delta$ that the job gets destroyed and a probability $\lambda^e$ that he will receive a new job offer. He can experience the following transitions:

- If he is not laid off and receives a job offer, he can accept it and switch to a new job or reject it and stay at his current job.
- If he is not laid off and does not receive a job offer, he has to remain on his current job.
- If he is laid off, he remains unemployed for at least one period.

If at age $a - 1$ the agent was unemployed with probability $\lambda^u$, he will receive a new job offer. He becomes employed if he receives and accepts a job offer; otherwise he remains unemployed.

During retirement, the agent does not work, he simply consumes by drawing down his pension and non-pension assets.

**2.2.2 Preferences**

The individual’s period utility is a function of consumption and employment during his working life and a function of consumption during retirement. The functional form assumed has the constant relative risk aversion property in consumption and is separable in consumption and employment. I allow for
unobserved heterogeneity in preferences through differences in risk aversion.\footnote{I allow for two types of individuals who differ in permanent features unobserved by the econometrician. Besides different coefficients of risk aversion, the two types of individuals have different intercepts in the wage component of the job offer distribution. This formulation of unobserved heterogeneity is common in dynamic programming models (see e.g. Wolpin (1984) and Van der Klaauw and Wolpin (2008).}

\begin{equation}
\begin{align*}
u_a &= \frac{\sum_{j=1}^{2} 1 - \sigma_j I(type=j)}{C_a^{\sigma_j}} \exp(\epsilon_a^c) + \gamma H_a + H_a^c \epsilon_a^h \quad \text{if } a < A^R \\
u_a &= \frac{\sum_{j=1}^{2} 1 - \sigma_j I(type=j)}{C_a^{\sigma_j}} - 1 \quad \text{if } a \geq A^R,
\end{align*}
\end{equation}

where $j$ denotes the person’s unobserved type, $H_a = 1$ if employed at age $a$, and $H_a = 0$ otherwise; $\gamma$ is the disutility of work. $\epsilon_a^c$ and $\epsilon_a^h$ are age-varying iid shocks to the marginal utility of consumption and to the marginal disutility of employment. There is no bequest motive.

### 2.2.3 Job Offer

Each new job offer is assumed to arrive randomly from a joint wage-pension offer distribution, denoted by $f(\omega, p)$, and is characterized by an initial hourly wage $\omega$ and a pension component $p$. The pension is modeled with a discrete distribution where $p = NP$ indicates no plan, $p = DB$ indicates a defined benefit plan and $p = DC$ indicates a defined contribution plan.
The logarithm of the initial hourly wage offer is modelled as:

\[
\ln \omega = \sum_{j=1}^{2} \beta_j I(\text{type} = j) + \beta_3 X + \beta_4 X^2 + \beta_5 E \\
+ \beta_6 I(p = DB) + \beta_7 I(p = DC) + \varepsilon \omega, \tag{2.2}
\]

where \(\varepsilon \omega\) is an iid mean-zero normal shock with variance \(\sigma^2_\omega\). \(X\) denotes years of experience and \(E\) stands for education.\(^{14}\) This formulation accommodates possible correlation between the offered wage, experience, education, and the type of pension plan – all of those coming from the employer side, but in this model, assumed to be exogenous.

### 2.2.4 Wage growth on the job

While on the job, the agent experiences wage growth due to specific human capital accumulation. His current wage \(w(\omega, k)\) depends on the initial wage draw \(\omega\) and the number of periods he has been working for the same employer \(k\). The wage growth function is:

\[
w(\omega, k) = \omega \exp(\alpha_1 k + \alpha_2 k^2) \tag{2.3}
\]

\(^{14}\)To ease the computational burden, in the estimation I allow for two education categories: college graduate and high school/some college. In addition, because the data does not provide information on experience, in the estimation, experience is approximated as a function of “age - 12 - 6” for high school/some college category and “age - 16 - 6” for college graduates.
2.2.5 Pension Plans

Defined benefit

In a DB scheme, the employer pays the worker an annuity upon retirement until his death that is a product of the generosity factor $\alpha$, the employee’s wage during his last year of employment, and the number of years the worker has been at the firm. DB plans are assumed to vest in five years. The worker is not entitled to any benefits if he leaves the firm with less than five years of tenure. The DB benefit (which will be received during retirement), earned up to date at current employer, is given by:\textsuperscript{15}

\begin{equation}
    d^B_a = \alpha w_a k_a \text{ if } k_a \geq 5 \tag{2.4}
\end{equation}

\begin{equation}
    d^B_a = 0 \text{ if } k_a < 5
\end{equation}

DB benefits in the model accumulate from former employers. Let $\tilde{d}^B_a$ denote all earned DB benefits from the individual’s former and current employers. In addition, it is assumed that once the worker dies, the firm does not pay any additional benefits. This is equivalent to assuming that the worker is single, because in reality most DB plans offer survivor benefits.\textsuperscript{16}

\textsuperscript{15}Even though in reality defined benefits are exposed to the risk of the employer going bankrupt, the model does not allow for it. The Pension Benefit Guaranty Corporation is a government body that backstops retirees’ benefits when a company defined benefit pension plan fails. It was created under the Employee Retirement Income Security Act of 1974. The PBGC insurance program pays pension benefits up to the maximum guaranteed benefit set by law to participants who retire at age 65 ($54,000 a year as of 2009).

\textsuperscript{16}Around 94% of DB plans offer joint and survivor annuity for married participants (see...
**Defined contribution**

Each period while working for an employer who sponsors a DC plan, the worker has the choice whether to contribute \((d_a = 1)\) or not to \((d_a = 0)\). If he chooses to contribute, he contributes a fixed fraction of his wage \(\rho\) and the firm matches at a fixed rate \(m\).\(^{17}\) If he chooses not to contribute, the firm does not either. The fractions \(\rho\) and \(m\) are assumed to be constant, known to the agent and are not variables of choice. While working for a DC-providing employer, the balance in the worker’s DC account accumulates according to:

\[
D_{a+1}^C = (D_a^C + d_a(\rho + m)w_a)(1 + r_{a+1}), \tag{2.5}
\]

where \(r_{a+1}\) is the rate of return on assets.

If the worker is not with a DC-providing employer but has had a DC plan through a former employer, the account balance still accumulates with the rate of return on assets:

\[
D_{a+1}^C = D_a^C (1 + r_{a+1}) \tag{2.6}
\]

---

\(^{17}\)In reality, in most DC-type plans, the employee can choose how much to contribute and the employer matches up to a certain percent. In addition, most DC plans have contribution limits. For example, for 401(k) plans in 2009, the pre-tax employee contribution limit is $16,500 for workers 50 or younger and $22,000 for workers over 50. The contribution limit for employers is set at 6% of the employee’s pre-tax compensation.

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Borrowing from the account or withdrawals before retirement are not allowed. When a worker leaves a DC-providing job, he carries his balance with him.\footnote{In most DC plans, when leaving the firm, the worker could roll over the funds into a tax-sheltered Individual Retirement Account (IRA), transfer the money to the new employer's plan or take a lump-sum payment at a penalty. Option 3 is excluded from the model, while options 1 and 2 are considered equivalent.} DC plans are assumed to vest immediately.\footnote{In DC plans, employee contributions always vest immediately. Employer contributions must fully vest within three years, or six years if vesting occurs gradually. However, on average vesting periods are shorter than in DB plans (see National Compensation Survey: Employee Benefits in Private Industry in the United States, 2002-2003, U.S. Department of Labor).}

\subsection*{2.2.6 Non-Pension Assets and Returns}

Besides having pension assets, the worker is able to save on his own. The rate of return on assets held at the end of period $a$, $r_{a+1}$ is realized at the beginning of period $a + 1$.

The law of motion for non-pension assets is:

\begin{equation}
A_{a+1} = A^*_a (1 + r_{a+1}),
\end{equation}

where $A^*_a$ is the stock of assets held at the end of $a$ and $A_{a+1}$ is the stock at the beginning of $a + 1$.

There is a liquidity constraint, so that assets at the end of the period cannot be negative, $A^*_a \geq 0$ and a consumption floor $C \min > 0$. The liquidity constraint prevents agents from borrowing against uncertain future income.

The rate of return is determined by a mean-reverting stochastic process
specified as:
\[ \ln(1 + r_{a+1}) = \ln(1 + \bar{r}) + \xi_a, \]  
\[ (2.8) \]

where \( \bar{r} \) is the mean rate of return and \( \xi_a \) is an idiosyncratic individual specific shock each period \( \xi_a \sim N(0, \sigma^2_\xi) \).\(^{20}\) Returns are defined to include capital gains, which means that \( r_{a+1} \) can be less than zero, corresponding to a capital loss.\(^{21}\) The same rate of return applies to both the DC pension account and the individual’s other assets.\(^{22}\) The stochastic rate of return is necessary in the model to capture the risk associated with saving on one’s own or through a DC plan. In reality, the rate of return will depend on the investment portfolio. Although portfolio choice is not explicitly modeled, the mean and variance of the rate of return have been calibrated to match those of actual defined contribution plans, using plan level data.\(^{23}\) In contrast, in DB plans, the investment risk is completely borne by the employer.

**Taxes and the budget constraint**

Under current law, pension benefits are taxed at withdrawal. In this model, this happens during retirement for both DB and DC plans. In addition, income

\(^{20}\)There is no aggregate uncertainty.

\(^{21}\)This specification is also used in Blau (2008).

\(^{22}\)The assumption is that the worker and the firm have access to the same asset markets. In that respect, given a certain wage offer, the only incentives for accepting a DC-type job come from the tax deferral and the employer match – not because the employer is better at managing the worker’s investments.

\(^{23}\)Center for Retirement Research at Boston College. 5500-CRR data: Panel of Current and Usable Form 5500 Data.
taxes are deferred on both employee and employer contributions to DC plans, and returns accrue tax-free during the individual’s working life.\footnote{Roth IRAs are an exception. Under a Roth IRA, individuals, whether employed or self-employed, voluntarily contribute post-tax funds to an individual retirement account (IRA). In contrast to the 401(k) plan, the Roth plan requires post-tax contributions, but allows for tax-free growth and distribution.} The progressive nature of income tax law provides an additional incentive for contributing to DC plans for high-income workers as compared with the low-income group.\footnote{Both employee’s and employer’s contributions to DC are exempt from income taxes. However, the employee still owes Social Security and Medicare taxes on his total pre-contribution earnings.} By $\tau_a(w_a, r_aA^*_a, d_a)$ I denote taxes paid at age $a$ which include federal income and payroll taxes, calculated using the rules in effect in 2006 and assuming individuals take the standard deduction. Taxes are a function of earnings and income which in turn depend on the individual’s decision to contribute or not to a DC plan.

The budget constraint can be written as:

If unemployed:

$$C_a = A_a - A^*_a + b_a - \tau_a, \quad (2.9)$$

where $b_a$ includes non-labor income, like family transfers and unemployment compensation net of out-of-pocket search costs.

If employed:

$$C_a = A_a - A^*_a + (1 - I(p = DC)\rho d_a)w_a - \tau_a \quad (2.10)$$
If retired:

\[
C_a = A_a - A^*_a + D^C_a - D^{C*}_a + \bar{d}^B_a - \tau_a \tag{2.11}
\]

\[
A_{a+1} = A_a^*(1 + \bar{\tau})
\]

\[
D^C_{a+1} = D^C_a(1 + \tau)
\]

In retirement, there is no uncertainty either in terms of rate of return (which is held at its’ mean value) nor in terms of life-expectancy; the agent simply withdraws his pension and non-pension assets.\(^{26}\)

### 2.2.7 The Agent’s Dynamic Programming Problem

At each age, given his employment status and his current assets (non-pension assets \(A_a\), defined contribution account balance \(D^C_a\) and earned annual defined benefit \(\bar{d}^B_a\)), the agent decides his employment status, whether to contribute or not if he has a DC plan, and his consumption or, equivalently, his level of assets at the end of period \(a\), \(A^*_a\). Initial assets are inherited. The agent’s problem can be characterized recursively by three Bellman equations.

During retirement, there is no uncertainty. The agent faces a fixed rate of return, receives income from his DB plans (if he had any) and draws down

\(^{26}\)The problem reverts to a non-stochastic cake-eating problem. These assumptions can be relaxed but are not essential to the model, first because the focus is on saving decisions of workers at younger ages, and second, at the point of retirement the individual could convert his assets to an annuity to insure himself.
his DC account and his own financial assets. The present discounted value of utility of a retired agent at age \( a \), \( V^R_a \), can be expressed as:

\[
V^R_a(A_a, D_a^C, \tilde{d}_a^B) = \max_{A_a^*, D_a^C^*} \{ u(C_a) + \beta[V^R_{a+1}(A_{a+1}, D_{a+1}^C, \tilde{d}_{a+1}^B)|A_a, D_a^C, \tilde{d}_a^B] \}
\]

subject to:

\[
C_a = A_a - A_a^* + D_a^C - D_a^C^* + \tilde{d}_a^B - \tau_a
\]

\[
C_a > C \text{ min}
\]

\[
A_a^* \geq 0
\]

\[
D_a^C^* \geq 0
\]

\[
A_{a+1} = A_a^*(1 + \tau)
\]

\[
D_{a+1}^C = D_a^C^*(1 + \tau)
\]

During his working life, the agent chooses whether to work or not, and also chooses between jobs. The value of unemployment at age \( a \) depends on pension and non-pension asset holdings, earned defined benefits and the vector of utility shocks, which we can denote as \( \epsilon_a = \{\epsilon_a^c, \epsilon_a^h\} \):
\[ V^u_a(A_a, D^C_a, \tilde{d}^B_a, \epsilon_a) = \max_{C_a} \{ u_a(C_a, 0, \epsilon_a) \}
\]

\[ + \beta \lambda^u \int \int \max[V^\epsilon_{a+1}(A_{a+1}, D^C_{a+1}, \tilde{d}^B_{a+1}, x, y, 0, \epsilon_{a+1}),
V^u_{a+1}(A_{a+1}, D^C_{a+1}, \tilde{d}^B_{a+1}, \epsilon_{a+1})]dF(x, y)dF_r(r)dF_\epsilon(\epsilon)
\]

\[ +(1 - \lambda^u) \int \int V^u_{a+1}(A_{a+1}, D^C_{a+1}, \tilde{d}^B_{a+1}, \epsilon_{a+1})dF_r(r)dF_\epsilon(\epsilon) \}\]

subject to:

\[ C_a = A_a + b - A^*_a - \tau_a \]

\[ C_a > C \text{ min} \]

\[ A^*_a \geq 0 \]

\[ A_{a+1} = A^*_a(1 + r_{a+1}) \]

The Bellman equation for an employed worker with asset holdings at the
beginning of \( a \), after the realization of the rate of return shock, \( (A_a, D^C_a, \tilde{d}^B_a) \),
who works at a firm offering initial wage \( \omega \) and pension type \( p \) and has \( k_a \)
years of tenure is:
\[ V^e_a(A_a, D^C_a, \tilde{d}^B_a, \omega, p, k_a, \epsilon_a) = \max_{C_a, d_a \in \{0, 1\}} \{ u_a(C_a, 1, \epsilon_a) \] 
\[ + \beta(1 - \delta) \lambda^e \int \int \max [ V^e_{a+1}(A_{a+1}, D^C_{a+1}, \tilde{d}^B_{a+1}, x, y, 0, \epsilon_{a+1}), \] 
\[ V^e_{a+1}(A_{a+1}, D^C_{a+1}, \tilde{d}^B_{a+1}, \omega, p, k_{a+1}, \epsilon_{a+1})] dF(x, y) dF_r(r) dF_\epsilon(\epsilon) \] 
\[ + \beta(1 - \delta)(1 - \lambda^e) \] 
\[ \times \int \int V^e_{a+1}(A_{a+1}, D^C_{a+1}, \tilde{d}^B_{a+1}, \omega, p, k_{a+1}, \epsilon_{a+1}) dF_r(r) dF_\epsilon(\epsilon) \] 
\[ + \beta \delta \int \int V^a_{a+1}(A_{a+1}, D^C_{a+1}, \tilde{d}^B_{a+1}) dF_r(r) dF_\epsilon(\epsilon) \] 

subject to:

\[ C_a = A_a + (1 - I(p = DC) \rho d_a) w_a - \tau_a - A^*_a \] 
\[ C_a > C_{\text{min}} \] 
\[ A^*_a \geq 0 \] 
\[ A_{a+1} = A^*_a(1 + r_{a+1}) \] 

2.2.8 Solution Method

The model is numerically solved by backward recursion. Because the state space includes continuous variables, e.g., the current level of the worker’s non-pension and pension assets, it is not possible to obtain exact solutions. Instead, I adopt an approximation technique similar to Keane and Wolpin (1994) and Van der Klaauw and Wolpin (2008). At each given point in the state space, the individual decides between jobs and on consumption so as to maximize total lifetime utility. For any given value of the deterministic and stochastic components of the state space, and for each of the possible choices of employ-
ment status, the agent optimizes with respect to consumption and the decision to contribute or not to the DC plan, taking into account the lower bound on assets and the consumption floor. The level of consumption and the contribution decision that maximize total utility are chosen for that value of the state space. At any deterministic state point, the expected value of maximal terminal utility is obtained by Monte Carlo integration. This expectation is calculated at a subset of the deterministic state points and the function is approximated for all other state points by linear interpolation.\textsuperscript{27} This procedure is repeated from $A^T$ to the initial age.

2.3 Data

This study uses the Panel Study of Income Dynamics (PSID) as the primary source of data. The PSID is a longitudinal survey conducted by the Survey Research Center at the Institute for Social Research at the University of Michigan. Beginning in 1968, the study followed the same set of households, emphasizing the dynamic aspects of their economic and demographic behavior. As of 2005, the sample size consists of almost 8000 households. The PSID is the preferred data in comparison to other datasets that also provide wage and pension data, because it allows the study of the wage-pension trade-off.

\textsuperscript{27}Future versions of the paper will try other approximation methods as well, such as a quadratic or cubic spline. I use 20 draws for the Monte Carlo integration and around 20,000 state points for the approximation.
for workers at different stages of their life cycle. Unlike the Health and Retirement Study, where the majority of the individuals are in the later phases of their working lives, the PSID reports the job market and savings decisions of individuals of all ages. Although in the past the pension data from the PSID has been somewhat limited, in 1999 a new section introduced detailed questions on pension participation, eligibility, type and number of plans, percent of worker and employer contributions and account balances. In addition, the PSID contains detailed information on other variables that enter the estimation, such as sociodemographic characteristics, education, employment status, income and wealth. So far, the 1999, 2001, 2003, 2005 and 2007 waves with detailed pension sections have been released.28

2.3.1 Sample Selection

The sample is designed to be relatively homogeneous with respect to a number of demographic characteristics. In particular, it includes only white males with at least high school education, who are between the ages of 26 and 55 for at least two waves of the data. In addition, any individual who reports attendance in school, self-employment, military service or participation in any government welfare program (i.e., AFDC, WIC or food stamps) over the sample period is excluded. Although the format of the PSID data makes the task of defining

28The current draft of the paper presents results from estimation based on the 1999 through 2005 waves of the PSID. An updated version of the paper will include the 2007 wave as well.
job changes somewhat difficult,\textsuperscript{29} in other respects the survey information is well-suited to the requirements of this analysis since it follows individuals for up to six years and includes data on both earnings, employment and type of pension plans held during the observation period. The sample size is 3,429 with 9,689 person-year observations. I define employment as working (35+ hours per week) year round (36+ weeks per year) or the equivalent of 1,260 hours. The annual earnings of individuals who were employed by this definition is the earnings measure. Non-pension assets are measured by the reported total net worth of the individual less DC accumulations and IRA accounts. In the estimation DC values include IRA accounts. All dollar amounts are inflated by the Consumer Price Index to 2006 dollars.

The generosity factor for DB pension, the contribution and match rate for DC pensions were chosen to be representative of the most popular pension plans in the US.\textsuperscript{30} The rate of return on DC assets was estimated from the 5500 plan-level data using actual return on DC investments for the period 1988-2006.

The average age of the sample is 42 years and roughly 83 percent of the workers are employed. Current job tenure is 9.3 years. It is lower for workers who are currently at employers that don’t provide pensions – 5.7 years, compared with 10.9 years for those who are at a pension-providing employer.

\textsuperscript{29}Since 1997 the interviews are done every couple of years.  
Job tenure is highest for workers with DB plans, 13.5 years compared with 9.6 years for workers with DC plans. This observation is consistent with the back-loaded nature of benefit accruals in DB plans, providing an incentive for workers to stay longer with their employer. The incentive in DC plans comes from the employer match, the tax deferral on contributions and returns, and rising wages with tenure. Still, because these plans are more portable across employers, one would expect average tenure in these jobs to be lower as compared with DB-type jobs, and that is indeed what the data shows. Moreover, the data suggest a positive relationship between earnings and pension coverage. Average annual earnings are $6,700 higher at jobs with pension coverage as compared with jobs without. In addition, workers at employers who offer a DB-type plan earn on average $1,200 more than workers with DC plans. Table 2.1 summarizes the statistics. These numbers, however, do not show us what the underlying reason is for the positive correlation between wages and pensions. One possibility is that job offers that include a pension plan, have a higher wage component as well. Another possibility is that high-productivity workers are more risk-averse and self-select into jobs with pension plans. The estimates of the model help disentangle these two effects.

Table 2.2 compares overall pension coverage by type of plan and age. Roughly 70 percent of employed workers are currently with an employer who offers a plan. In the sample, this percent slightly decreases with age. It is
Table 2.1: Sample Statistics

<table>
<thead>
<tr>
<th></th>
<th>No pension at current employer:</th>
<th>Pension Plan at current employer:</th>
<th>If Pension Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of workers with</td>
<td>31.5</td>
<td>69.5</td>
<td>65.9</td>
</tr>
<tr>
<td>Mean current job tenure (years)</td>
<td>5.7</td>
<td>10.9</td>
<td>9.6</td>
</tr>
<tr>
<td>Mean annual earnings</td>
<td>$55,342</td>
<td>$62,069</td>
<td>$61,672</td>
</tr>
</tbody>
</table>

interesting to note that of those with plans, younger workers are more likely to have a DC versus a DB plan, and the opposite is true for older workers.\(^{31}\) On average, 66 percent of all jobs with pensions offer DC plans and 34 percent offer DB plans.

### 2.4 Estimation

Estimating the behavioral model presents two challenges. The first one arises from the fact that the PSID samples people of all ages, hence the decisions observed for the majority of the people, do not start at the beginning of their life

\(^{31}\) There are two potential explanations for this observation. One is related to the pension type shift and captures cohort effects: DB plans were more popular in the past, and with tenure rising with age, we would expect to see older workers today more likely to be still in DB-type jobs. The other explanation has to do with risk aversion and liquidity constraints – younger workers move between jobs more often and are more liquidity constrained, so they would prefer DC-type plans, while older workers might be more risk-averse and prefer the DB option. The setup of the model does not allow us to isolate the cohort effects. Ideally, one would like to make the pension component of the job offer distribution depend on time or birth cohort. Unfortunately, that is very computationally burdensome because it introduces another state variable that takes on many values. This is left for future research.
cycles but at some later period and are thus conditioned on state variables that arise from prior unobserved decisions. Direct estimation will lead to inconsistent estimates if those “initial” conditions are not exogenous – that is, if there is unobserved heterogeneity in preferences or constraints. In the estimation this problem is addressed by assuming that the probabilities of the unobserved heterogeneity types can be represented by parametric functions of the initial state variables. If the shocks are serially independent, then the initial state variables will be exogenous given type.\textsuperscript{32} The second problem arises due to the biennial nature of the PSID – some of the state variables are missing every other year. This problem is harder to solve with a likelihood-based estimation approach. It would require integrating over the distribution of the missing state variables. Because the missing observations include elements of the state variables.

\textsuperscript{32}For a discussion of the initial conditions problem and possible solutions, see Aguirregabiria and Mira (2009)
space that take on many values (e.g., assets are treated as continuous), this approach poses a huge computational burden.

I therefore pursue a non-likelihood-based estimation strategy, efficient method of moments, henceforth EMM, which is a type of indirect inference (see Gallant and Tauchen 1996, Gourieroux and Monfort 1996, Smith 1993). EMM is a generalization of the method of simulated moments. It is particularly useful when a model is not analytically tractable, but can be easily simulated. The basic idea is to find a set of structural parameters that minimize the distance between a set of moments from the data and the model-predicted counterparts of these moments based on simulated data from the structural model. The set of the moments that are matched can be viewed as a set of auxiliary parameters from a set of auxiliary statistical models. These auxiliary models can be structural or reduced form, and they should provide a complete enough statistical description of the data and simulations to be able to identify the behavioral parameters. Following Van der Klaauw and Wolpin (2008), I use a combination of approximate decision rules (that link endogenous outcomes of the model and elements of the state space) and modified structural relationships (such as the wage equations).

More specifically, using actual data, \( y_A \), I estimate a set of \( M_A \) auxiliary statistical relationships with parameters \( \theta_A \). By construction, at the maximum likelihood estimates \( \hat{\theta}_A \), the scores of the likelihood function \( (L_j \) for
$j = 1, \ldots, M_A$) are zero. That is, \( \frac{\partial L_j}{\partial \theta_{A,j}} = 0 \) where \( \theta_{A,j} \) is the vector of model \( j \)'s parameters. Denoting \( \theta_B \) the parameters of the behavioral model, the idea of EMM is to choose parameters that generate simulated data \((y_B(\theta_B))\) that make the score functions as close to zero as possible. This is accomplished by minimizing the weighted squared deviations of the score functions evaluated at the simulated data. The EMM estimator of \( \theta_B \) is thus:

$$
\hat{\theta}_B = \arg \min_{\theta_B} \frac{\partial L}{\partial \theta_A}(y_B(\theta_B); \hat{\theta}_A) \Lambda \frac{\partial L}{\partial \theta_A'}(y_B(\theta_B); \hat{\theta}_A), \quad (2.12)
$$

where \( \Lambda \) is a weighting matrix and \( \frac{\partial L}{\partial \theta_A}(y_B(\theta_B); \hat{\theta}_A) \) is a vector collecting the scores of the likelihood functions across auxiliary models. When \( M_A = 1 \), the optimal weighting matrix is the inverse Hessian and has a limiting normal distribution.\(^{33}\) For tractability, I estimate \( M_A \) auxiliary models separately and choose as a weighting matrix a block diagonal matrix \( \Lambda^* \) such that each block is a consistent estimate of the inverse Hessian of the corresponding auxiliary model evaluated at the actual data. The estimator is consistent when the number of simulated observations grows proportionately with the number of actual observations as the latter goes to infinity.

\(^{33}\)See Gourieroux et al. (1993).
2.4.1 The Auxiliary Statistical Models

The solution of the optimization problem of section 2 is a set of decision rules in which the optimal choice made in any decision period is a function of the state space in that period. Parametric approximations to these decision rules will serve as one class of auxiliary models to be used in the estimation. Following Van der Klaauw and Wolpin (2008), to keep these approximations parsimonious (as to preserve precision in the parameter estimates), I do not include all the state variables as suggested by the theory, and for that reason it is best to think of them as “restricted” approximate decision rules. A second set of auxiliary models comprises quasi-structural relationships related to the wage equation.

The specific type of parametric approximation adopted depends on whether the choice and state variables are discrete or continuous. The following list consists of auxiliary models used in estimation:

1. Logits of unemployment versus employment on combinations of experience, education, tenure, lagged net worth and lagged DC balance.

2. Logits of unemployment to employment transitions on combinations of experience, education, tenure, lagged net worth and lagged DC balance.

3. Logits of job-to-job transitions on experience, education, tenure, current and lagged pension type, lagged DC assets and lagged net worth.

5. Multinomial logits of unemployment, work in job without pension, job with DB, job with DC pension on combinations of experience, education, tenure, lagged employment status, lagged DC balance and lagged net worth.


7. Regressions of net assets on age, lagged net worth, lagged employment status, lagged pension status and lagged DC balance.

8. Regressions of log wages on experience, education, lagged log wage, tenure and DB/DC dummies.

9. Regression of within job wage growth on tenure.

Currently in the estimation, 149 score functions are used to identify 25 parameters of interest.
2.4.2 Simulating the Data for Estimation

I perform path simulations in the following way. For each trial value of the structural parameters, and having solved the optimization problem, simulating one-step-ahead decisions is straightforward if all the state variables are observed. For example, consider a hypothetical individual who is 30 years old in 1999 and who is observed for seven 12-month periods, i.e., through age 36. Given the state variables at his 1999 interview, a simulation of the decision at age 30 for that individual would be obtained by drawing a vector of the disturbances and choosing the alternative with the highest value function. Similar simulations can be obtained at ages 31-36 based on the actual state variables. However, because of the biennial nature of the data, many state variables are missing every other year. So the actual state variables are used only for 1999, 2001, 2003 and 2005. For 2000, the state variables are derived by updating the 1999 state variables by the 1999 decisions. Similarly, the 2002 and 2004 state variables are the result of the 2001 and 2003 decisions.

The unobserved heterogeneity is incorporated in the following way. The probability that a simulated individual is of a given type depends on his initial state variables. Given that probability, each simulated observation is assigned the particular type by drawing randomly from the type probability function.

Having simulated the data, the criterion function (2.12) is calculated for
each of the auxiliary models.\textsuperscript{34} I iterate on the parameters using the Newuoa derivative-free optimization algorithm (Powell 2008) until the sum over the auxiliary models of (2.12) is minimized. The parameters of interest include the parameters of the job offer distribution, the wage-growth function, the utility function and the type probability function.

\subsection*{2.4.3 Identification}

Identification is achieved through variation in individual outcomes and choices, embedded constraints and parametric assumptions. A common identification difficulty of job search models is to separately identify the job offer rates from the parameters of the utility function.\textsuperscript{35} Because only accepted job offers are observed, the econometrician could not distinguish between the individual’s decision not to work being the result of receiving a job offer that is below his reservation utility or not receiving an offer this period. In this particular version of the model, identification is solved by assuming fixed offer and lay-off rates, which are not part of the estimation.\textsuperscript{36} The observed employment choices (and the type of pension plans at those jobs) help identify the pa-

\textsuperscript{34}For the purpose of calculating the score function, I perform 20 simulations for each sample observation.

\textsuperscript{35}Except for cases where the incidence of job offers is observed in the data.

\textsuperscript{36}These assumptions can be relaxed in future versions of the paper. Even though the reasons for leaving a job are not observed in the PSID, the setup of the model allows for the identification of layoff rates from the observed transitions of employment to unemployment. As regards the offer rates, in general, the identification would be achieved through information on transition rates of unemployment to employment, functional form assumptions on the wage distribution and the reservation utility property.
rameters in the disutility of work and the coefficient of relative risk aversion. Risk-averse individuals do not like fluctuations in consumption. Hence, the coefficient of risk aversion is identified by the degree to which workers make choices as to smooth consumption. In the model this can be achieved through two channels – employment decision and precautionary savings. Employment, particularly at pension-offering jobs, will be more valuable to risk-averse individuals (given the same wage, DB plans are more attractive than DC plans because of zero investment risk). In addition, for the same type of pension plan at the current employer, variations in non-pension saving and the incidence of contributions to DC plans bring further information for the identification of the risk-aversion parameter.\textsuperscript{37}

The main goal of the estimation is to find the parameters of the utility function and the job offer distribution, in order to uncover the mechanism that leads to the observed positive correlation between labor earnings and pension coverage in the data. If there are unobserved permanent differences between workers that make some workers more productive (hence get higher wage offers) and at the same time more risk averse (hence prefer pension-type jobs), they will self-select into jobs with high wages and pension plans. Ignoring this permanent component to the unobserved shock in the wage part

\textsuperscript{37}The identification of the coefficient of risk aversion is facilitated also by the assumption of a common discount factor, which is taken as a given. Thus, variations in saving outcomes across individuals is attributed solely to differences in observable characteristics and the coefficient of relative risk aversion.
of the job offer (2.2) will lead to bias in the other estimates of the wage equation and make us wrongly conclude that the positive correlation is solely due to the lack of compensating wage differential in the job offer. Thus, the unobserved heterogeneity in the model serves another purpose besides solving the initial conditions problem. In the estimation, I allow for two latent type of workers that permanently differ in risk aversion and in the intercept of the wage equation. Identification of the type proportions is achieved through across-group variation in wages and asset accumulations.

2.5 Results

In this section, I present results from the estimation of the model described in section 2.2 and using data from the 1999 to 2005 waves of the PSID.

2.5.1 Parameter Estimates

Parameter estimates are provided in tables 2.3 and 2.4. With respect to the job offer distribution, wage offers peak at 28 years of experience. College graduates have on average 40 percent higher wage offers. Jobs that offer DC plans tend to offer wages that are 19.3 percent higher than no-pension jobs. Jobs that come with DB plans offer wages that are 25.6 percent higher as compared with no-pension jobs. The estimates of the discrete part of the job offer distribution imply that the probability of receiving an offer with no pension is 40.1 percent,
Table 2.3: Parameter Estimates: Job Offer

Log Wage Equation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unobserved Type 1 intercept</td>
<td>2.17</td>
</tr>
<tr>
<td>Unobserved Type 2 intercept</td>
<td>2.86</td>
</tr>
<tr>
<td>Experience</td>
<td>0.0398</td>
</tr>
<tr>
<td>Experience^2</td>
<td>-0.00072</td>
</tr>
<tr>
<td>College Graduate</td>
<td>0.401</td>
</tr>
<tr>
<td>DB-type offer</td>
<td>0.256</td>
</tr>
<tr>
<td>DC-type offer</td>
<td>0.193</td>
</tr>
<tr>
<td>Standard error of wage shock</td>
<td>0.689</td>
</tr>
</tbody>
</table>

Pension Offer

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prob DB plan</td>
<td>0.189</td>
</tr>
<tr>
<td>Prob DC plan</td>
<td>0.410</td>
</tr>
</tbody>
</table>

Wage Growth on Job

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tenure</td>
<td>0.029</td>
</tr>
<tr>
<td>Tenure^2</td>
<td>-0.00036</td>
</tr>
</tbody>
</table>

An offer with a DC-type pension is 41 percent and 18.9 percent for a DB-type offer. While on the job, wages tend to increase with tenure, but at a decreasing rate, and peak at 41 years.

The estimates also point to considerable differences between the two unobserved types of individuals that were modeled. Everything else held constant, Type 2 individuals receive on average wage offers that are almost twice as high as that of Type 1 individuals. With respect to preferences, Type 1 individuals are less risk averse than Type 2 individuals. The coefficients of
Relative risk aversion are estimated to be 0.81 and 1.69, respectively. These numbers fall within the range of other findings in the literature. The disutility of work is found to be -0.003. The calibrated values of the parameters held fixed in estimation can be found in Table 2.12 in the appendix.

Overall, the estimates are consistent with both of the potential explanations for the positive correlation between wages and pensions observed in the data. On one hand, pension-type jobs come on average with higher wage offers, so one would expect in the cross-section to observe workers with pension coverage to have higher earnings as well – thus no evidence for the existence of a compensating differential between wages and pensions has been found. On the other hand, the estimates suggest two distinct types of unobserved heterogeneity in terms of risk aversion. Given the savings incentives provided with two types of pension plans, one would expect the more risk-averse individuals

---

\[^{38}\text{Van der Klaauw and Wolpin (2008) report estimates of 1.68 and 1.59; Rendon (2006) reports an estimate of 1.48.}\]
to sort into jobs with pensions and stay there longer. Moreover, the more risk-averse individuals have on average higher wage offers, which also leads to a positive relationship between earnings and pension coverage.

2.5.2 Model Fit

Tables 2.5-2.8 provide evidence on the within-sample fit as well as demonstrating other characteristics of the model. The model predictions are based on a simulated sample, consisting of 20 replicas for each sample individual. The central feature of the model is how individuals choose between jobs based on the wage and pension characteristics. Thus, the model should fit well the pension coverage trends in the data, as well as tenure and earning by types of plans.

Table 2.5 reports pension coverage (defined as currently at a job that offers a pension) by type and age. Roughly 70 percent of workers in the sample currently work for an employer that offers pensions. The model follows this number relatively closely. Of those who are at a pension job, roughly 70 percent are at a DC-type job and 30 percent are at a DB-type job. Younger workers are more likely to be at a DC-type job compared with older workers, who are more likely to be at a DB-type job. This trend is matched by the model as well, however, the model slightly overpredicts the percent of workers at DC jobs and underpredicts the percent of workers at DB type jobs. This
could be due to cohort effects, which the model is not able to capture.

Table 2.5: Model Fit: Actual and Predicted Pension Coverage, by Age

<table>
<thead>
<tr>
<th>Age</th>
<th>Actual</th>
<th>Predicted</th>
<th>Actual</th>
<th>Predicted</th>
<th>Actual</th>
<th>Predicted</th>
</tr>
</thead>
<tbody>
<tr>
<td>26-35</td>
<td>71.5</td>
<td>68.0</td>
<td>69.6</td>
<td>72.7</td>
<td>30.4</td>
<td>27.3</td>
</tr>
<tr>
<td>36-45</td>
<td>69.3</td>
<td>70.0</td>
<td>65.3</td>
<td>69.4</td>
<td>34.7</td>
<td>30.1</td>
</tr>
<tr>
<td>46-55</td>
<td>68.4</td>
<td>70.5</td>
<td>64.0</td>
<td>66.4</td>
<td>36.0</td>
<td>34.0</td>
</tr>
</tbody>
</table>

Table 2.6: Model Fit: Actual and Predicted Average Tenure, by Pension Coverage and Age

<table>
<thead>
<tr>
<th>Age</th>
<th>Actual</th>
<th>Predicted</th>
<th>Actual</th>
<th>Predicted</th>
<th>Actual</th>
<th>Predicted</th>
<th>Actual</th>
<th>Predicted</th>
</tr>
</thead>
<tbody>
<tr>
<td>26-35</td>
<td>4.1</td>
<td>4.2</td>
<td>5.8</td>
<td>5.3</td>
<td>5.4</td>
<td>5.0</td>
<td>6.7</td>
<td>6.0</td>
</tr>
<tr>
<td>36-45</td>
<td>5.6</td>
<td>6.1</td>
<td>10.6</td>
<td>9.6</td>
<td>9.5</td>
<td>8.5</td>
<td>12.7</td>
<td>12.1</td>
</tr>
<tr>
<td>46-55</td>
<td>6.9</td>
<td>6.9</td>
<td>14.9</td>
<td>13.4</td>
<td>12.9</td>
<td>11.5</td>
<td>18.4</td>
<td>17.3</td>
</tr>
</tbody>
</table>

Table 2.6 compares actual and predicted statistics for mean tenure at current job, by age and pension coverage. The model closely tracks average tenure by age groups. Average tenure rises with age for all categories, but especially for workers currently with a DB plan. Average tenure at no-pension
Table 2.7: Model Fit: Actual and Predicted Average Annual Earnings, by Pension Coverage and Age

<table>
<thead>
<tr>
<th>Age</th>
<th>Actual</th>
<th>Predicted</th>
<th>Actual</th>
<th>Predicted</th>
<th>Actual</th>
<th>Predicted</th>
<th>Actual</th>
<th>Predicted</th>
</tr>
</thead>
<tbody>
<tr>
<td>26-35</td>
<td>$46,037</td>
<td>$42,354</td>
<td>$50,778</td>
<td>$48,788</td>
<td>$51,010</td>
<td>$49,122</td>
<td>$50,247</td>
<td>$47,899</td>
</tr>
<tr>
<td>36-45</td>
<td>$54,741</td>
<td>$54,813</td>
<td>$64,742</td>
<td>$64,815</td>
<td>$65,434</td>
<td>$64,835</td>
<td>$63,442</td>
<td>$64,769</td>
</tr>
<tr>
<td>46-55</td>
<td>$61,671</td>
<td>$59,702</td>
<td>$67,454</td>
<td>$69,571</td>
<td>$66,088</td>
<td>$69,494</td>
<td>$69,883</td>
<td>$69,724</td>
</tr>
</tbody>
</table>

Table 2.8: Selected Characteristics by Type

<table>
<thead>
<tr>
<th></th>
<th>Type 1</th>
<th>Type 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion</td>
<td>38.3</td>
<td>61.7</td>
</tr>
<tr>
<td>% employed</td>
<td>87.4</td>
<td>83.6</td>
</tr>
<tr>
<td>% no pension if employed</td>
<td>47.2</td>
<td>33.0</td>
</tr>
<tr>
<td>% DC plan if employed with pension</td>
<td>72.2</td>
<td>67.6</td>
</tr>
<tr>
<td>% DB plan if employed with pension</td>
<td>27.8</td>
<td>32.4</td>
</tr>
<tr>
<td>Average tenure if no pension</td>
<td>5.4</td>
<td>6.4</td>
</tr>
<tr>
<td>Average tenure if DC plan</td>
<td>6.2</td>
<td>10.0</td>
</tr>
<tr>
<td>Average tenure if DB plan</td>
<td>7.5</td>
<td>15.1</td>
</tr>
<tr>
<td>% contributing of those with DC plan</td>
<td>78.5</td>
<td>57.4</td>
</tr>
<tr>
<td>Average earnings</td>
<td>$46,564</td>
<td>$68,195</td>
</tr>
<tr>
<td>Average DC assets at age 55</td>
<td>$38,000</td>
<td>$99,371</td>
</tr>
<tr>
<td>Average non-pension assets at age 55</td>
<td>$158,404</td>
<td>$167,833</td>
</tr>
</tbody>
</table>

jobs is lower than at pension jobs for all age groups. The model is successful in replicating this trend. Both the data and the prediction show that average
tenure is much higher at DB-type jobs as compared with DC and no-pension jobs.

Table 2.7 presents actual and predicted statistics for annual earnings by age and pension coverage at current job. The model captures the concave relationship between earnings and age. Moreover, as was previously noted, there exists a positive correlation between earnings and pension coverage in the data. The model captures this trend both qualitatively and quantitatively. For all age groups, earnings at no-pension jobs are lower than earnings at pension-offering jobs. In addition, workers in the first two age categories, currently with DC plans, earn on average more than workers with DB plans. For the highest age group, the reverse is true – DB-type jobs are associated with higher earnings. The model captures the trend but overpredicts earnings at DC-type jobs by 4.5 percent.

Although not specifically related to the model fit, Table 2.8 highlights the importance of accounting for unobserved heterogeneity. The estimates show that 38 percent of the individuals in the sample are Type 1 and 62 percent are of Type 2. Type 2 workers are more risk-averse and more productive – they tend to get higher wage offers, everything else held constant. On average, Type 2 workers earn 46.5 percent more annually than Type 1 workers. Because of higher risk aversion and the desire to smooth consumption, these type of workers self-select into jobs that offer pension plans. Table 2.8 shows that
while 47.2 percent of Type 1 workers have no pension at their current job, this number is only 33 percent for Type 2 workers. Moreover, because DB plans don’t have investment risk, Type 2 workers are more likely than Type 1 workers to choose a DB-type job. As Table 2.8 reports, among workers with a pension, 32.4 percent of Type 2 workers work for a DB-providing employer, compared with 27.8 percent of Type 1 workers. In addition, the more risk-averse individuals tend to stay longer at their current job. Average tenure for these workers – in all non-pension, DB and DC-type jobs is much higher than average tenure for the less risk-averse types. Positive returns to tenure further contribute to their relatively higher earnings. As a result of higher risk aversion, a higher wage offer, longer tenure and a higher probability of choosing a pension-type job, Type 2 individuals approach their retirement years with 6 percent more non-pension assets but as much as 160 percent more DC assets as compared with Type 2 individuals.

2.6 Policy Experiments

One of the goals of this paper is to determine how policy changes will impact workers’ job choice decisions and thus determine their earnings and saving for retirement outcomes. The estimates indicate two underlying factors behind the observed higher pension coverage and higher pension assets among the high earners as compared with low earners in the data. On the one hand, a positive
correlation between the wage and pension components of the job offers coming from the employer side suggests the existence of “good” and “bad” jobs – those that provide both a high salary and a pension and those that provide neither. On the other hand, there is positive sorting among workers in the sense that more productive workers, who on average receive higher wage offers, are also more risk averse and as a way to smooth consumption prefer to go to jobs that offer pension plans.\(^{39}\)

In this section, I use the estimates of the model to see how changes in the types and incentives of the two pension plans will affect workers outcomes. I simulate histories of 10,000 artificial agents using the estimated structural parameters. Each agent begins life at age 26, at which time he is randomly assigned employment status, tenure, wage, pension and non-pension assets, all chosen so as to match the proportions observed in the data. At age 26, each worker is also assigned an unobserved type by drawing from the type distribution. Each period from age 26 to 66, the agent receives a draw from the distribution of the disturbances and makes optimal employment, job and savings choices. The choices he makes determine the values of the state variables at the end of the period, which are passed forward to the next period. The process repeats until the individual reaches retirement at age 66. From

\(^{39}\)It is worth highlighting the partial equilibrium setup of the model. As such, the demand side of the labor market is considered completely exogenous. When interpreting the results, as well as the policy experiments, one has to keep in mind the underlying assumption that in the model, the employers are not allowed to adjust their behavior. The effects that we are witnessing show solely how workers adjust their behavior to changes in the environment.
age 66 to 80, the agent just consumes his pension and non-pension assets and faces no uncertainty. These simulations provide the benchmark against which I compare the policy experiments.

2.6.1 Mandatory Contribution in DC plans

The first policy experiment is motivated by the recent literature on the effect of defaults on savings outcomes in respect to defined contribution pension plans. These studies have pointed out the failure of eligible workers to join the plan or contribute as two of the reasons why the majority of households in the U.S. enter retirement with only modest DC balances.\(^40\) Currently, most companies in the U.S. offering DC-type plans require active election on the part of employees to participate and contribute. That is, if the employee does nothing, the default is that he will not be enrolled in the plan (“standard enrollment”). An alternative but less widely used approach is to enroll employees automatically in the plan, requiring them to actively opt out of participation. Previous studies have indicated that even such a simple change in the default can have drastic impact on participation and savings outcomes.\(^41\)

In light of the model in this paper, I conduct a policy experiment that takes the automatic enrollment provision to an extreme and imposes mandatory contributions for workers who are currently with an employer who offers

\(^{40}\)Munnell and Sunden (2006).

\(^{41}\)For a detailed overview on the effects of default options in DC plans, see Beshears et al. (2006).
a DC plan. The percent contribution and the employer match rate are held fixed at 6 and 3 percent of earnings, respectively (and as discussed in the model). What is of interest is the effect on workers’ pension coverage, and savings outcomes due to this policy change.42

Instituting mandatory contributions in DC plans will make them less attractive to workers who might have otherwise chosen not to contribute – either because of liquidity constraints or lower risk aversion. This will raise the relative attractiveness of non-pension and DB jobs. Indeed, overall pension coverage drops from 68.7 percent to 67.4 percent – caused by a decrease in the percent of workers at DC-type jobs (from 69.8 percent to 68.8 percent), which cannot be fully compensated by the increase in the percent of workers at DB-type jobs (30.1 percent to 31.2 percent).

Table 2.9 shows the effect of mandatory contributions on non-pension and DC balances. Across all age groups, we observe an increase in accumulated DC balances due to the mandatory nature of contributions and because the drop in DC coverage is too small to have significant effects on overall accumulations. The increase in DC account balances varies from 30 percent for the youngest age group to more than 60 percent for the oldest. At the same time, workers compensate with saving less on their own. The drop in mean

42It should be noted that given the current model, in which agents behave optimally, such a policy change, which eliminates one of the choices, previously available to workers, will necessarily result in a welfare loss. The question of what would make workers not behave optimally in the first place and thus justify such a policy change is beyond the scope of this paper and is left for future research.
non-pension assets varies from 18 to 5 percent from the youngest to oldest. Overall, mandatory contributions have caused an increase of $27,700 in total assets (or an equivalent of 10 percent) for the group that is closest to retirement (46 to 55 years old).\textsuperscript{43} This result has clear policy implications. If the goal is to stimulate more savings for retirement, this experiment shows that workers will not fully counterbalance with saving less on their own or avoid DC jobs completely. Mandatory DC contributions can potentially have positive effects on overall savings. However, overall pension coverage is lower, so the increase in overall savings is not uniformly distributed in the population.

\begin{table}[h]
\centering
\caption{Effect of Mandatory Contributions in DC plans}
\begin{tabular}{lcccc}
\hline
\textbf{Age} & \textbf{Benchmark} & \textbf{Experiment} & \textbf{Benchmark} & \textbf{Experiment} \\
\hline
26-35 & $48,106$ & $39,446$ & $8,965$ & $12,008$ \\
36-45 & $137,274$ & $123,546$ & $26,900$ & $41,836$ \\
46-55 & $221,574$ & $210,495$ & $59,194$ & $98,034$ \\
\hline
\end{tabular}
\end{table}

\subsection*{2.6.2 Complete phaseout of DB plans}

The second experiment analyzes the effect of pension offer probabilities on retirement savings and job mobility. Consistent with the pension-type shift, this counterfactual experiment aims to uncover what we should expect to observe in terms of pension coverage and asset accumulations in a world in which \textsuperscript{44}

\textsuperscript{43}Change in earned DB benefits is minuscule.
defined benefit plans are completely eclipsed by defined contribution plans.

This experiment involves eliminating altogether the defined benefit pension from the wage-pension offer distribution and replacing it with defined contribution type of plan. The probability of receiving a job offer with no pension is kept at its estimated value of 40.1 percent, while the probability of receiving an offer with a DC plan is increased to 59.9 percent. An additional assumption is that there is no adjustment in offered wages. Essentially, the experiment assumes that all employers who used to offer DB plans now switch to DC plans and they adjust their offered wage according to the already estimated wage-offer distribution. Still, because workers’ histories are simulated using the initial conditions as of age 26 in the data, we would expect to see a small percentage of older workers in the future holding DB-type jobs – those are the ones who stayed with their initial DB-sponsoring employer.

<table>
<thead>
<tr>
<th>Age</th>
<th>Benchmark</th>
<th>Experiment</th>
<th>Benchmark</th>
<th>Experiment</th>
<th>Benchmark</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>26-35</td>
<td>$48,106</td>
<td>$47,345</td>
<td>$8,965</td>
<td>$9,972</td>
<td>$793</td>
<td>$524</td>
</tr>
<tr>
<td>36-45</td>
<td>$137,274</td>
<td>$134,867</td>
<td>$26,900</td>
<td>$32,712</td>
<td>$2,160</td>
<td>$770</td>
</tr>
<tr>
<td>46-55</td>
<td>$221,574</td>
<td>$219,246</td>
<td>$59,194</td>
<td>$73,385</td>
<td>$3,958</td>
<td>$841</td>
</tr>
</tbody>
</table>

The elimination of DB-type offers leads to a slight decrease in overall pension coverage, from 68.7 percent to 68.3 percent. By the time they reach
46-55 years of age, virtually all of the workers with pension coverage have a DC-type plan (99.3 percent) – the rest are the ones who held on to their original DB job from age 26. Because of the more mobile nature of DC plans, workers change jobs more often, and as a result, average tenure in the population drops almost a year, – from 9.3 years in the benchmark case to 8.4 years when DB plans are absent.

In addition, because DC-type jobs are more ubiquitous, workers at such jobs are slightly less likely to contribute: percent of workers contributing fall from 64.5 percent to 64 percent. However, because of the higher percentage of workers at such jobs, the overall mean DC assets among those 46 to 55 years old increase by $14,000 (24 percent higher than the benchmark case). This is met by a corresponding decrease in non-pension assets of $2,000 for the same age group.

However, to assess the overall effect on savings for retirement, we need to take into account DB benefits as well. Because of the elimination of defined benefit plans, workers in all age groups have less earned defined benefits from former or current employers. On average, the annual earned DB benefit for the oldest age group drops by $3,000, which in terms of present discounted value as of age 50, is equivalent to a $20,000 loss in wealth. As a result, this policy experiment suggests that overall net assets of the 46 to 55 age group are expected to drop by an average of $8,000. Overall, this experiment raises
concerns that the elimination of DB type of plans might leave workers with less savings for retirement. Table 2.10 reports the statistics.

2.6.3 Suspension of tax deferral on pension contributions

Third, I evaluate the effect of a change in the tax treatment of pension contributions. The goal is to assess how important the tax incentive is in stimulating savings. Specifically, in this experiment, tax deferral on DC contributions is eliminated, which means that employees are now required to pay income taxes on both their own and the employer matching contributions to the DC account. In addition, returns on DC accumulations are taxed during working years, but no taxes are paid on withdrawals during retirement. In this environment, the only incentive for saving through a DC plan as compared with saving on your own is through the employer match.

Table 2.11: Effect of Suspension of Tax Deferral on Pension Contributions

<table>
<thead>
<tr>
<th>Age</th>
<th>Mean non-pension assets</th>
<th>Mean DC balance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Benchmark</td>
<td>Experiment</td>
</tr>
<tr>
<td>26-35</td>
<td>$48,106</td>
<td>$48,247</td>
</tr>
<tr>
<td>36-45</td>
<td>$137,274</td>
<td>$138,223</td>
</tr>
<tr>
<td>46-55</td>
<td>$221,574</td>
<td>$223,230</td>
</tr>
</tbody>
</table>

In DB plans, only the employer makes contributions, which are also tax
deferred. In this experiment, employees have to include in their taxable income for the year the contribution that the employer makes on their behalf\textsuperscript{44}, but they will not pay taxes on the DB benefit while receiving it in retirement.

No tax incentives leads to a small drop of overall pension coverage, from 68.7 percent to 68.2 percent. The flow out of DC jobs is slightly higher than that of DB jobs – percent with DC coverage drops by 0.3 percentage points compared with 0.2 percentage point in DB coverage, which suggests that workers value tax incentives more in DC-type plans. Table 2.11 reports overall drop in DC balances of 17 percent for the oldest age group (or equivalently $10,000), which cannot be offset by the compensating increase in non-pension assets of less than $2,000. There is almost no change in earned defined benefits. Overall, this experiment suggests that tax incentives have higher importance in defined contribution plans as compared with defined benefit plans. Their elimination would result in an overall decrease in net assets of around $8,000 for the 46 to 55 age group.

\subsection{2.7 Conclusion}

This paper studies the trade-off that workers face when choosing between compensation in the form of wages versus pension contributions. From a policy

\textsuperscript{44}The employer contribution is calculated by finding the present discounted value as of today of the annuity that the employee earned while working during this particular year (given his wage, tenure and vesting status). A real discount rate of 3\% was used.
standpoint, if we want to understand how people save for retirement and how policy can affect their behavior, we need to account for the endogeneity of pension coverage. Previous studies have often overlooked the fact that workers’ job search process simultaneously determines their wage and savings outcomes. In this chapter I formulate, solve and estimate a life cycle model in which people search for jobs, consume and save on their own and through their employer so as to maximize utility. What makes this framework different from the classical job search model is the fact that the job offer is a wage-pension package, which also allows both wages and pensions to be endogenously determined. The decision of a worker to accept or reject a job offer is the result of an interplay between his preferences and the set of incentives and risks associated with the offered pension plan.

The model is estimated on a sample from the PSID data using the method of indirect inference. It fits many aspects of the data reasonably well. The estimates show positive correlation between wages and pensions in the compensation packages that employers offer, as well as positive sorting of high-productivity, highly risk-averse individuals into jobs with pensions – thus providing no evidence for the existence of a compensating differential coming from the employer side.

The estimates of the behavioral parameters are used to address a series of policy questions. Switching from voluntary to mandatory contributions for
all workers with DC-type jobs results in lower overall pension coverage, but
due to an incomplete crowdout effect of forced DC savings, the average worker
is predicted to approach retirement with as much as 10 percent more overall
assets.

Eliminating the tax incentives on pension contributions also leads to
lower pension coverage and lower DC accumulations, which are not fully offset
by an increase in non-pension savings. Last but not least, changes in the type
of plans offered (i.e., a phaseout of DB plans) would lead to higher overall
DC accumulations, but on average about 3 percent lower overall savings for
retirement.
Bibliography


Keane, M. P. and K. I. Wolpin (1994). The solution and estimation of dis-


### 2.8 Appendix

**Table 2.12: Parameters Held Fixed in Estimation**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layoff rate</td>
<td>0.07</td>
</tr>
<tr>
<td>Discount factor</td>
<td>$1/(1+0.03)$</td>
</tr>
<tr>
<td>Job offer rate if employed</td>
<td>0.3</td>
</tr>
<tr>
<td>Job offer rate if unemployed</td>
<td>$\frac{\exp(-2+0.18age-0.0016age^2)}{1+\exp(-2+0.18age-0.0016age^2)}$</td>
</tr>
<tr>
<td>Employee contribution rate DC</td>
<td>0.06</td>
</tr>
<tr>
<td>Employer match rate DC</td>
<td>0.5</td>
</tr>
<tr>
<td>Generosity factor DB</td>
<td>0.015</td>
</tr>
<tr>
<td>Rate of return on assets (mean)</td>
<td>0.046</td>
</tr>
<tr>
<td>Rate of return on assets (st. dev.)</td>
<td>0.12</td>
</tr>
<tr>
<td>Consumption floor</td>
<td>0</td>
</tr>
</tbody>
</table>