

# Evaluating the Wage-Pension Trade-Off in a Dynamic Model of Search and Savings

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## Abstract

Standard labor theory suggests a negative relationship between the wage and non-wage components of compensation packages. Yet, the empirical evidence on the existence of a compensating wage differential for pension benefits has been mixed. Previous studies have often overlooked the fact that workers' wage and pension benefits are simultaneously determined by their job choice decisions. This paper estimates a life cycle model in which individuals search for jobs, consume, save on their own and through their employer-provided pension. Job offers are wage-pension packages which allows both wages and pensions to be endogenously determined. The estimates show positive correlation between the wage and pension components of the packages that employers offer, as well as positive sorting of high-productivity, highly risk averse individuals into jobs with pensions as compared to no-pension jobs. Policy experiments indicate that making contributions mandatory in defined contribution plans results in lower overall pension coverage, but an increase in defined contribution balance accumulations which is higher than the drop in non-pension saving. The elimination of tax incentives on pension contributions leads to lower pension coverage and overall asset accumulations. Complete phaseout of defined benefit plans, could lead to lower overall savings for retirement.

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# 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.<sup>1</sup> Most of the studies that address this question estimate the wage-pension trade-off using a hedonic pension-earnings equation.<sup>2</sup> 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. Not all employers offer pensions, and of those that do, most offer just one

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<sup>1</sup>Schiller and Weiss (1980), Ehrenberg (1980), Smith (1981) and, later, Montgomery et al. (1992) and Gunderson et al. (1992) all find some evidence for the existence of a wage-pension trade-off. On the contrary, Gustman and Steinmeier (1986) find no trade-off, but rather a significantly positive relationship. Using an alternative benefit measure of pension benefits, Inkmann (2006) finds empirical evidence for compensating wage differentials for pension benefits provided by occupational DB and DC pension schemes in the UK.

<sup>2</sup>See a survey paper by Gustman et al. (1994).

pension plan.<sup>3</sup> 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.<sup>4</sup> An observed positive correlation between wages and pensions could be simply due to the fact that more productive workers, who would also receive higher wages, are the ones who care more about the future. They consciously choose to work for employers who offer pensions and thus end up with both a high wage and high pension assets.

The questions addressed in this paper are: 1) What is the trade-off, from the worker's perspective, that he faces when choosing between compensation in the form of wages versus pension benefits; and consequently what is the mechanism that leads to the observed positive correlation between wages and pensions in the data; 2) How will policies that change the distribution or incentives of pension plans affect pension coverage and savings for retirement?

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 – defined benefit (DB), defined contribution (DC) or no

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<sup>3</sup>Decressin et al. (2005).

<sup>4</sup>For today's retirees, the employer-provided pension benefits are the second largest component of retirement income. They are surpassed only by Social Security benefits, and are twice as big as other forms of personal savings (Munnell and Perun 2006).

plan.<sup>5</sup> The worker's decision to accept or reject a job offer is the result of interplay between his 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 search process.

The model is designed to capture the main differences between the two types of plan, 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.<sup>6</sup> 2) Higher job mobility among workers with DC plans, compared to those with DB plans.<sup>7</sup>

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 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

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<sup>5</sup>Defined benefit and defined contribution are currently the two major types of private pension plans in the US (see Munnell and Perun 2006).

<sup>6</sup>Pension 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 Perun 2006).

<sup>7</sup>See Munnell et al. (2006).

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.<sup>8</sup> 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 worker are more likely to have DB-type plans as compared with DC-type plans or no pension plans.

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 own savings accounts. Thus the more risk averse the individual, the more willing he will be to substitute today's wages for tomorrow's secure pension income; the more likely he will be to accept a DB-type job.<sup>9</sup>

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.

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<sup>8</sup>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.

<sup>9</sup>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.

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.

In addition, differences in expected future offers and career paths based on unobserved worker characteristics (like innate ability) could also influence the wage-pension decision. I allow for both observed and unobserved heterogeneity in preferences and job offers.

The model is estimated on the Panel Study of Income Dynamics (PSID) data via the method of indirect inference. The estimates indicate 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. 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 lower overall pension coverage but an increase in DC balance accumulations in the population, which is higher than the drop in non-pension savings. As a result, workers approach retirement with as much as 14 percent more overall assets. 2) Complete phaseout<sup>10</sup> of DB plans from the job-offer distribution could lead 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 accu-

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<sup>10</sup>Although pension coverage has remained stagnant, the type of coverage has changed dramatically. Pensions have shifted from traditional defined benefit (DB) plans to defined contribution (DC) plans. 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).

mulations, which are not fully offset by an increase in non-pension savings.

The remainder of this paper is organized as follows. Related literature is reviewed below. Section 2 presents the dynamic job search model and the solution approach. The main features of the data are presented in section 3. Section 4 discusses the estimation procedure. Section 5 presents the results. Section 6 discusses policy experiments. Section 7 concludes.

## 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 paper 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 to be better at 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 theo-

retical framework to build a better intuition of how the saving for retirement decision interrelates with job choice and employment decisions of workers at younger ages.

Last but not least, this project 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 Schragger (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 Model**

This section describes a dynamic stochastic model of employment and savings decisions of an unmarried individual from a point in his lifecycle 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.

## 2.1 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.<sup>11</sup> 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 contribute or not to that plan ( $d_a = 1$  if he contributes,  $d_a = 0$  if otherwise). Employment choices are constrained by whether or not the individual worked in the previous period.

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, there is no uncertainty: the agent simply consumes by drawing down his pension and non-pension assets.

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<sup>11</sup>In the estimation,  $A^T = 80$  and  $A^R = 66$ .

## 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 separate in consumption and employment. I allow for unobserved heterogeneity in preferences through differences in risk aversion.<sup>12</sup>

$$u_a = \frac{C_a^{\sum_{j=1}^2 1 - \sigma_j I(\text{type}=j)} - 1}{1 - \sum_{j=1}^2 \sigma_j I(\text{type} = j)} \exp(\epsilon_a^c) + \gamma H_a + H_a \epsilon_a^h \quad \text{if } a < A^R \quad (1)$$

$$u_a = \frac{C_a^{\sum_{j=1}^2 1 - \sigma_j I(\text{type}=j)} - 1}{1 - \sum_{j=1}^2 \sigma_j I(\text{type} = j)} \quad \text{if } a \geq A^R,$$

where  $H_a = 1$  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.

## 2.3 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

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<sup>12</sup>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)).

wage  $\omega$  and a pension component  $p$  :

$$f(\omega, p) = f(\omega) * q_l, 0 < \omega < \infty, q_l = pr(p = p_l) \quad (2)$$

$$l = \{NP, DB, DC\}$$

The pension is modeled with a discrete distribution where  $l = NP$  indicates no plan,  $l = DB$  indicates a defined benefit plan and  $l = DC$  indicates a defined contribution plan.

The logarithm of the initial hourly wage offer received at age  $a$  is modelled as:

$$\ln \omega_a = \sum_{j=1}^2 \beta_j I(\text{type} = j) + \beta_3 X_a + \beta_4 X_a^2 + \beta_5 E_a \quad (3)$$

$$+ \beta_6 I(p_a = DB) + \beta_7 I(p_a = DC) + \varepsilon_a^\omega,$$

where  $\varepsilon_a^\omega$  is an iid mean-zero normal shock with variance  $\sigma_\omega^2$ ,  $X_a$  denotes years of experience and  $E_a$  stands for education.<sup>13</sup> 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.

## 2.4 Wage growth on the job

While on the job, the agent experiences wage growth due to specific human capital accumulation. His current wage  $w_a(\omega, k_a)$  depends on the initial wage

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<sup>13</sup>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.

draw  $\omega$  and the number of periods he has been working for the same employer  $k_a$ . The wage growth function is:

$$w_a(\omega, k_a) = \omega \exp(\alpha_1 k_a + \alpha_2 k_a^2) \quad (4)$$

## 2.5 Pension Plans

### 2.5.1 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<sup>14</sup>:

$$\begin{aligned} d_a^B &= \alpha w_a k_a \text{ if } k_a \geq 5 \\ d_a^B &= 0 \text{ if } k_a < 5 \end{aligned} \quad (5)$$

DB benefits in the model accumulate from former employers. By  $\tilde{d}_a^B$  I 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 more benefits. This is equivalent to assuming that the

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<sup>14</sup>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).

worker is single, because in reality most DB plans offer survivor benefits.<sup>15</sup>

### 2.5.2 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  $m$ .<sup>16</sup> If he chooses not to contribute, the firm does not either. The fractions  $\rho$  and  $m$  are assumed to be constant and are not variables of choice. While working for a DC-providing employer, the balance in the worker's DC account accumulates according to:

$$D_{a+1}^C = (D_a^C + d_a(\rho + m)w_a)(1 + r_{a+1}), \quad (6)$$

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:

$$D_{a+1}^C = D_a^C(1 + r_{a+1}) \quad (7)$$

Borrowing from the account or withdrawals before retirement are not allowed. When a worker leaves a DC-providing job, he carries his balance

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<sup>15</sup>Around 94% of DB plans offer joint and survivor annuity for married participants (see National Compensation Survey: Employee Benefits in Private Industry in the United States, 2002-2003, U.S. Department of Labor).

<sup>16</sup>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.

with him.<sup>17</sup> DC plans are assumed to vest immediately.<sup>18</sup>

## 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:

$$A_{a+1} = A_a^*(1 + r_{a+1}), \quad (8)$$

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  $a + 1$ :

$$A_a^* = A_a + I_a - C_a \quad (9)$$

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:

$$\ln(1 + r_{a+1}) = \ln(1 + \bar{r}) + \xi_a, \quad (10)$$

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<sup>17</sup>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.

<sup>18</sup>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).

where  $\bar{r}$  is the mean rate of return and  $\xi_a$  is an idiosyncratic individual specific shock  $\xi_a \sim N(0, \sigma_\xi^2)$ .<sup>19</sup> Returns are defined to include capital gains, which means that  $r_{a+1}$  can be less than zero, corresponding to a capital loss.<sup>20</sup> The same rate of return applies to both the DC pension account and the individual's other assets.<sup>21</sup> 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 modelled, the mean and variance of the rate of return have been calibrated to match those of actual defined contribution plans, using plan level data.<sup>22</sup> In contrast, in DB plans, the investment risk is completely born by the employer.

### 2.6.1 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 taxes are deferred on both employee and employer contributions to DC plans, and returns accrue tax-free during the individual's working life.<sup>23</sup> The progressive nature of income tax law provides an additional incentive for contributing to DC plans for high-income workers as compared with the

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<sup>19</sup>There is no aggregate uncertainty.

<sup>20</sup>This specification is also used in Blau (2008).

<sup>21</sup>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.

<sup>22</sup>Center for Retirement Research at Boston College. 5500-CRR data: Panel of Current and Usable Form 5500 Data.

<sup>23</sup>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.

low-income group.<sup>24</sup> By  $\tau_a$  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.

The budget constraint can be written as:

If unemployed:

$$C_a = A_a + b_a - \tau_a - A_a^* , \quad (11)$$

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

If employed:

$$C_a = A_a + (1 - I(p = DC)\rho d_a)w_a - \tau_a - A_a^* \quad (12)$$

If retired:

$$C_a = A_a - A_a^* + D_a^C - D_a^{C*} + \tilde{d}_a^B - \tau_a \quad (13)$$

$$A_{a+1} = A_a^*(1 + \bar{r})$$

$$D_{a+1}^C = D_a^{C*}(1 + \bar{r})$$

In retirement, there is not uncertainty – the rate of return is held fixed; the agent simply withdraws his pension and non-pension assets.<sup>25</sup>

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<sup>24</sup>However, the employee still owes Social Security and Medicare taxes on his total pre-contribution earnings.

<sup>25</sup>The problem reverts to a non-stochastic cake-eating problem.

## 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  $D_a^C$  and earned annual defined benefit  $\tilde{d}_a^B$ ), the agent decides on 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 his DC account and his own financial assets. The present discounted value of utility of a retired agent at age  $a$ ,  $V_a^R$ , can be expressed as:

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

subject to:

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

$$C_a > C \min$$

$$A_a^* \geq 0$$

$$D_a^{C*} \geq 0$$

$$A_{a+1} = A_a^*(1 + \bar{r})$$

$$D_{a+1}^C = D_a^{C*}(1 + \bar{r})$$

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  $\epsilon_a = \{\epsilon_a^c, \epsilon_a^h\}$  :

$$\begin{aligned}
V_a^u(A_a, D_a^C, \tilde{d}_a^B, \epsilon_a) = & \max_{C_a} \{u_a(C_a, 0, \epsilon_a) \\
& + \beta[\lambda^u \int \int \int \max[V_{a+1}^e(A_{a+1}, D_{a+1}^C, \tilde{d}_{a+1}^B, x, y, 0, \epsilon_{a+1}), \\
& V_{a+1}^u(A_{a+1}, D_{a+1}^C, \tilde{d}_{a+1}^B, \epsilon_{a+1})]dF(x, y)dF_r(r)dF_\epsilon(\epsilon) \\
& + (1 - \lambda^u) \int \int V_{a+1}^u(A_{a+1}, D_{a+1}^C, \tilde{d}_{a+1}^B, \epsilon_{a+1})dF_r(r)dF_\epsilon(\epsilon)\}
\end{aligned}$$

subject to:

$$C_a = A_a + b - A_a^* - \tau_a$$

$$C_a > C \min$$

$$A_a^* \geq 0$$

$$A_{a+1} = A_a^*(1 + r_{a+1})$$

The Bellman equation for an employed worker with asset holdings at the beginning of  $a$ , after the realization of the rate of return shock,  $(A_a, D_a^C, \tilde{d}_a^B)$ , who works at a firm offering initial wage  $\omega$  and pension type  $p$  and has  $k_a$  years of tenure is:

$$\begin{aligned}
V_a^e(A_a, D_a^C, \tilde{d}_a^B, \omega, p, k_a, \epsilon_a) = & \max_{C_a, d_a \in \{0,1\}} \{u_a(C_a, 1, \epsilon_a) \\
& + \beta(1 - \delta)\lambda^e \int \int \int \max[V_{a+1}^e(A_{a+1}, D_{a+1}^C, \tilde{d}_{a+1}^B, x, y, 0, \epsilon_{a+1}), \\
& V_{a+1}^e(A_{a+1}, D_{a+1}^C, \tilde{d}_{a+1}^B, \omega, p, k_{a+1}, \epsilon_{a+1})]dF(x, y)dF_r(r)dF_\epsilon(\epsilon) \\
& + \beta(1 - \delta)(1 - \lambda^e)* \\
& * \int \int V_{a+1}^e(A_{a+1}, D_{a+1}^C, \tilde{d}_{a+1}^B, \omega, p, k_{a+1}, \epsilon_{a+1})dF_r(r)dF_\epsilon(\epsilon) \\
& + \beta\delta \int \int V_{a+1}^u(A_{a+1}, D_{a+1}^C, \tilde{d}_{a+1}^B)dF_r(r)dF_\epsilon(\epsilon)
\end{aligned}$$

subject to:

$$C_a = A_a + (1 - I(p = DC)\rho d_a)w_a - \tau_a - A_a^*$$

$$C_a > C \min$$

$$A_a^* \geq 0$$

$$A_{a+1} = A_a^*(1 + r_{a+1})$$

## 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 employment 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.<sup>26</sup> This procedure is repeated from  $A^T$  to the initial age.

## 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

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<sup>26</sup>I plan to 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.

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 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.<sup>27</sup>

### 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 between the ages of 26 and 55 with at least a high school education. 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

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<sup>27</sup>The 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.

the format of the PSID data makes the task of defining job changes somewhat difficult,<sup>28</sup> 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 wages, 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. Financial assets are measured by the total net worth of the individual. 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.<sup>29</sup> 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 41.9 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. 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

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<sup>28</sup>The interviews are done every couple of years.

<sup>29</sup>See the National Compensation Survey: Employee Benefits in Private Industry in the United States, 2002-2003, U.S. Department of Labor.

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 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 1: Sample Statistics

	No pension at current employer:	Pension Plan at current employer:	If Pension Plan	
			DC plan	DB plan
% of workers with	31.5	69.5	65.9	34.1
Mean current job tenure (years)	5.7	10.9	9.6	13.5
Mean annual earnings	\$55,342	\$62,069	\$61,672	\$62,838

Table 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 interesting to note that of those with plans, younger workers are more likely to have a DC versus DB plan, and the opposite is true for older workers.<sup>30</sup> On average, 66 percent of all jobs with pensions offer DC plans and 34 percent offer DB plans.

Table 2: Sample Statistics: Pension Coverage by Type and Age

Age	% working for an employer who offers pensions	% with DC plan if working for an employer who offers pensions	% with DB plan if working for an employer who offers pensions
26-35	71.5	69.6	30.4
36-45	69.3	65.3	34.7
46-55	68.3	64.0	36.0

## 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

<sup>30</sup>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.

observed for the majority of the people, do not start at the beginning of their life 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 solved 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.<sup>31</sup> 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 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 real 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.

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<sup>31</sup>For a discussion of the initial conditions problem and possible solutions, see Aguirregabiria and Mira (2009)

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  $\widehat{\theta}_A$ , the scores of the likelihood function ( $L_j$  for  $j = 1, \dots, M_A$ ) 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:

$$\widehat{\theta}_B = \arg \min_{\theta_B} \frac{\partial L}{\partial \theta_A}(y_B(\theta_B); \widehat{\theta}_A) \Lambda \frac{\partial L}{\partial \theta'_A}(y_B(\theta_B); \widehat{\theta}_A), \quad (14)$$

where  $\Lambda$  is a weighting matrix and  $\frac{\partial L}{\partial \theta_A}(y_B(\theta_B))$  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.<sup>32</sup> 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

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<sup>32</sup>See Gourieroux et al. (1993).

number of actual observations as the latter goes to infinity.

## 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.
4. Multinomial logits of 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.

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.
6. Logits of contribution versus non-contribution for workers in DC plans on experience, education, wage, tenure, 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.

## 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 (14) is calculated for each of the auxiliary models.<sup>33</sup> I iterate on the parameters using the Newuoa derivative-free optimization algorithm (Powell 2008) until the sum over the auxiliary models of (14) 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.

### 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.<sup>34</sup> Because only accepted job offers are observed, the econometrician could not distinguish between the individual's

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<sup>33</sup>For the purpose of calculating the score function, I perform 20 simulations for each sample observation.

<sup>34</sup>Except for cases where the incidence of job offers is observed in the data.

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 facilitated by the assumption of fixed offer and layoff rates, which are not part of the estimation.<sup>35</sup> The observed employment choices (and the type of pension plans at those jobs) help identify the parameters 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.<sup>36</sup>

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

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<sup>35</sup>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.

<sup>36</sup>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.

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 of the job offer (3) 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.

## 5 Results

In this section, I present preliminary results from the estimation of the model described in section 2 and using data from the 1999 to 2005 waves of the PSID.

### 5.1 Parameter Estimates

Parameter estimates are provided in tables 3 and 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, an offer with a DC-type pension is 41 percent and

Table 3: Parameter Estimates: Job Offer

<u>Log Wage Equation</u>	
Unobserved Type 1 intercept	2.17
Unobserved Type 2 intercept	2.86
Experience	0.0398
Experience <sup>2</sup>	-0.00072
College Graduate	0.401
DB-type offer	0.256
DC-type offer	0.193
Standard error of wage shock	0.689
<u>Pension Offer</u>	
Prob DB plan	0.189
Prob DC plan	0.410
<u>Wage Growth on Job</u>	
Tenure	0.029
Tenure <sup>2</sup>	-0.00036

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 the existence of two unobserved types of individuals. 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 find-

Table 4: Parameter Estimates: Utility Function

Coefficient of relative risk aversion (type1)	0.81
Coefficient of relative risk aversion (type 2)	1.69
Disutility from work	-0.003
St error employment shock	0.289
St error consumption shock	0.177

ings in the literature.<sup>37</sup> 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 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. 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 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.

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<sup>37</sup>Van der Klaauw and Wolpin (2008) report estimates of 1.68 and 1.59; Rendon (2006) reports an estimate of 1.48.

## 5.2 Model Fit

Tables 5-8 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 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 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 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 7 presents actual and predicted statistics for annual earnings by age

Table 5: Model Fit: Actual and Predicted Pension Coverage, by Age

	% working for an employer who offers pension		% with DC plan if working for an employer who offers pension		% with DB plan if working for an employer who offers pension	
Age	Actual	Predicted	Actual	Predicted	Actual	Predicted
26-35	71.5	68.0	69.6	72.7	30.4	27.3
36-45	69.3	70.0	65.3	69.4	34.7	30.1
46-55	68.4	70.5	64.0	66.4	36.0	34.0

Table 6: Model Fit: Actual and Predicted Average Tenure, by Pension Coverage and Age

	Tenure if no pension coverage at current employer		Tenure if pension coverage at current employer		Tenure if DC plan at current employer		Tenure if DB plan at current employer	
Age	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted
26-35	4.1	4.2	5.8	5.3	5.4	5.0	6.7	6.0
36-45	5.6	6.1	10.6	9.6	9.5	8.5	12.7	12.1
46-55	6.9	6.9	14.9	13.4	12.9	11.5	18.4	17.3

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.

Table 7: Model Fit: Actual and Predicted Average Annual Earnings, by Pension Coverage and Age

	Annual earnings if no pension coverage at current employer		Annual earnings if pension at coverage current employer		Annual earnings if DC plan at current employer		Annual earnings if DB plan at current employer	
Age	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted
26-35	\$46,037	\$42,354	\$50,778	\$48,788	\$51,010	\$49,122	\$50,247	\$47,899
36-45	\$54,741	\$54,813	\$64,742	\$64,815	\$65,434	\$64,835	\$63,442	\$64,769
46-55	\$61,671	\$59,702	\$67,454	\$69,571	\$66,088	\$69,494	\$69,883	\$69,724

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 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 8 shows that while 47.2 percent of Type 1 workers have no pension at their current

Table 8: Selected Characteristics by Type

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

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 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.

## 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 savings 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, care more about the future and, as a way to smooth consumption, prefer to go to jobs that offer pension plans.<sup>38</sup>

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,

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<sup>38</sup>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.

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 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.

## 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.<sup>39</sup> 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

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<sup>39</sup>Munnell and Sunden (2006).

outcomes.<sup>40</sup>

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 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.<sup>41</sup>

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 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

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<sup>40</sup>For a detailed overview on the effects of default options in DC plans, see Beshears et al. (2006).

<sup>41</sup>It 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.

time, workers compensate with saving less on their own. The drop in mean 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 14 percent) for the group that is closest to retirement (46 to 55 years old).<sup>42</sup> 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.

Table 9: Effect of Mandatory Contributions in DC plans

Age	Mean non-pension assets		Mean DC balance	
	Benchmark	Experiment	Benchmark	Experiment
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

## 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

<sup>42</sup>Change in earned DB benefits is minuscule.

which defined benefit plans are completely eclipsed by define 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 10: Effect of Complete Phaseout of DB plans

	Mean non-pension assets		Mean DC balance		Mean earned annual defined benefit	
Age	Benchmark	Experiment	Benchmark	Experiment	Benchmark	Experiment
26-35	\$48,106	\$47,345	\$8,965	\$9,972	\$793	\$524
36-45	\$137,274	\$134,867	\$26,900	\$32,712	\$ 2,160	\$770
46-55	\$221,574	\$219,246	\$59,194	\$73,385	\$3,958	\$841

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 10 reports the statistics.

### **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 11: Effect of Suspension of Tax Deferral on Pension Contributions

Age	Mean non-pension assets		Mean DC balance	
	Benchmark	Experiment	Benchmark	Experiment
26-35	\$48,106	\$48,247	\$8,965	\$7,085
36-45	\$137,274	\$138,223	\$26,900	\$21,211
46-55	\$221,574	\$ 223,230	\$59,194	\$48,995

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<sup>43</sup>, 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 3 percentage points compared with 2 percentage point in DB coverage, which suggests that workers value tax incentives more in DC-type plans. Table 11 reports overall

<sup>43</sup>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.

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.

## 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 standpoint, if we want to understand how people save for retirement and how policy can affect their behavior, we need to understand the mechanism that leads to the observed positive relationship between wages and pensions in the data.

This is a particularly important question, given the recent shifts in the type of pension coverage and the different incentives and risks of the new type of plans. This paper suggests a new approach for addressing this question, which focuses on the idea that the wage versus pension benefit decision is crucially related to the job search and saving for retirement decisions. 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. 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 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.

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 an increase in DC balance accumulations that more than compensates the drop in non-pension savings. As a result, workers approach retirement with as much as 14 percent more in 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) could lead to higher overall DC accumulations, but lower overall savings for retirement.

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## A Appendix

Table 12: Parameters Held Fixed in Estimation

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

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