Why are Defined Benefit Pensions Disappearing?

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Abstract

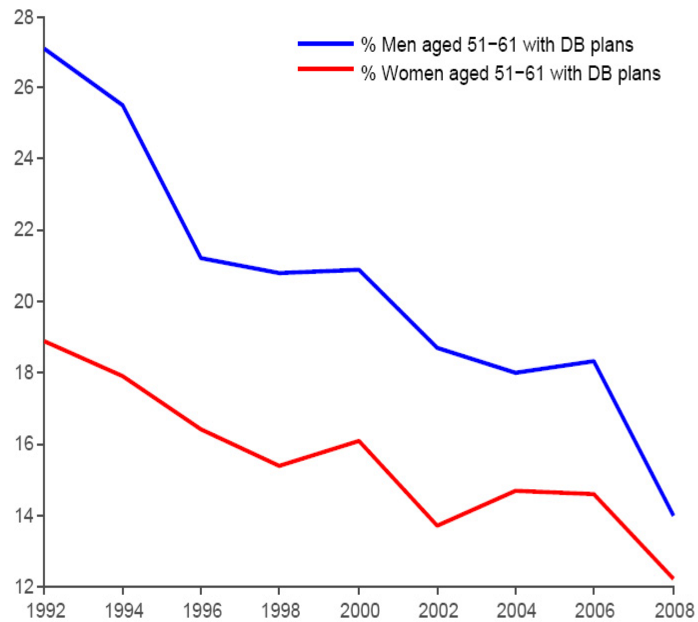
Workers are entering retirement today more exposed to longevity risk than they were twenty years ago. This paper examines the effect of declining job tenure as a motivation to switch from a defined benefit pension to other forms of retirement saving. The price of longevity insurance is determined endogenously in a standard lifecycle model with heterogeneous survival. A worker has a decision over his compensation package, and an option to quit his job if a better offer arrives. The terms of the defined benefit contract and the involuntary separation rate are taken exogenously. The contract is defined by three characteristics: it is illiquid, there is a fixed cost, and it subsidizes workers with long tenure at the expense of workers who leave the job with low tenure. The illiquidity of the contract allows firms to offer higher returns than the market by avoiding some adverse selection effects. At the same time, the fixed cost and potential cross-subsidization make the plan unattractive to workers who do not expect long tenure with the firm. An increase in the separation rate leads to fewer workers taking the defined benefit pension. Without the pension, they are more likely to quit when a better offer comes along, increasing the endogenous quit rate and further decreasing average tenure.

1 Introduction

Defined benefit pensions are employer promises to pay an employee a fixed annual (or monthly) amount in retirement every year. The payment is a function of wage, age and tenure. A defined contribution pension is more like a savings account, with a lump-sum distribution at retirement. The number of retirees covered by defined benefit (DB) pensions has declined over the past two decades. Figure 1 shows the downward trend for both men and women. The fall in DB pension coverage has received little attention from macroeconomists, even as financial analysts and policymakers worry about low pension coverage and over-reliance on 401(k) plans. Defined contribution (DC) plans have been replacing DB plans, but do not serve as longevity insurance. There is usually an option to roll the DC account into an annuity at retirement, but individual annuities suffer from adverse selection, driving up their price, see Finkelstein and Poterba (2002). The result has been a fall in longevity insurance coverage, and more workers enter retirement with the risk of outliving their savings, Survey of Consumer Finances (1992-2007).

This paper asks if the fall in job tenure can account for the decline in DB pensions. Demand for DB pensions arises in a standard lifecycle model with private information over survival probability. Workers choose their compensation. They may take a wage equal to their marginal product, or a lower wage and accumulate promises for retirement payments (a DB pension). Because employers are able to pool employees of different risk types with the same contract, they can offer a lower price on longevity insurance than the private market, which suffers more from adverse selection. The illiquidity of the DB plan also helps avoid adverse selection post-retirement. Low survival agents holding individual annuities will cash them out early in retirement, but DB pensioners do not have this option. Besides the illiquidity, the DB pension contract differs from an individual annuity in two other ways. Policy requires a fixed cost to insure against employer default. Also, the contract subsidizes employees with long tenure at the expense of employees that leave the job with short tenure. These characteristics make the DB plan

Figure 1: Defined Benefit Pension Prevalence 1992-2008, *Source:* HRS



unattractive to employees who do not expect long tenure with a firm.

Workers may be exogenously separated from their job, or leave voluntarily when matched with a higher-productivity firm. Workers are less likely to quit if they have already invested in a defined benefit pension with their employer. The exogenous separation rate will increase to generate the fall in expected tenure observed in the data over the past two decades. The result will be fewer workers taking defined benefit pensions and increased job turnover from not just exogenous separation, but also increased endogenous turnover. The environment without cross-subsidization matches 1992 levels of pension demand, but over-predicts the decline in defined benefit pensions. The environment with cross-subsidization predicts [result here].

1.1 Background

In the early 1970s some high profile companies defaulted on the defined benefit pensions they had promised employees. This lead to the 1974 Employee Retirement Income Security Act (ERISA), creating The Pension Benefit Guarantee Corporation (PBGC), with the purpose of insuring defined benefit pensions offered by the private sector. The legislation required employers to pay for the insurance. Average pension premiums have risen over the years since the PBGC's inception, but do not seem to be solely responsible for the new aversion to defined benefit pensions, Gotbaum (2011). What changed?

There has been one trend in the labor market that did not go unnoticed by economists in the 1990s: declining job stability. Farber (2007) compared Current Population Survey (CPS) data from 1973-2006 and found a downward trend of long-term relationships in the private sector. Valleta (2000) looked at the Panel Study of Income Dynamics (PSID) from 1976-1993 and found declining job security for all men and white-collar women. Bernhardt et al. (2000) compares National Longitudinal Survey (NLS) data from 1966-81 to 1979-94 and found a higher separation rate for the younger cohort. The labor market has experienced increases in both dismissals and quits, especially for longer-tenure workers, Valleta (2007).

It has been proposed that incentives connecting workers to their jobs have changed, Neumark (2000), but empirical research tends to focus on only one aspect of the pension contract at a time, Gustman et al. (1994). Haverstick et al. (2010) for example, show that workers with defined contribution plans and 5 to 10 years of tenure are 23% more likely to leave their job than similarly tenured workers with a defined benefit plan. Friedberg et al. (2006) is the first to connect the incentive structure of the defined benefit contract to the labor market with a search model. They find that either lower search costs or improved matching can lower the value of deterring search and reduce defined benefit offers by employers. This paper also endogenizes employee compensation, but instead of examining the supply side of pensions, employee incentives are considered. In practice, private pensions tend to be voluntary Dorsey et al. (1998). In the model, they will be as well.

Table 1(a) shows median worker tenure rates by age for men in 1991 and 2006. Tenure has fallen across every age group. Table 1(b) shows the percent of employed workers with 10 years or more of tenure with their current employer. Long-term tenure rates also show a consistent drop across all age groups.

Table 1: Employee Tenure Trends

(a) Median Tenure Rates for Men

Age Group	1991	2006
25-34	3.1	2.9
35-44	6.5	5.1
45-54	11.2	8.1
55-64	13.4	9.5

Source: BLS.

(b) Percent of Employed Men with 10 Years or More of Tenure with Current Employer

Age Group	1991	2006
25-29	5.7	2.6
30-34	21.1	11.6
35-39	35.6	24.7
40-44	46.3	34.8
45-49	53.5	42.9
50-54	58.5	49.7
55-59	61.0	51.0
60-64	57.5	48.1

Source: BLS.

When a firm takes on a new employee with a DB pension, the insurance premium has to be paid every year until the firm has no further obligation to the employee. Annual insurance premiums consist of a fixed cost, and a variable cost depending on the funding level of the pension. A firm with a fully-funded pension account pays the same insurance cost for an employee who stays with the firm 10 years as an employee who stays 30 years. It should not be surprising that firms require a vestment period before workers earn any claim to future payments. Workers with very short tenure taking DB plans are very expensive to an employer. Other explanations for the vestment period include training costs for firm-specific capital as in Ippolito (1997), or delayed compensation as an incentive against shirking as in Lazear (1979). This paper will transfer the insurance cost from the employer to the employee during the vestment period, so an employee will only take a DB plan when the expected benefits exceed the costs.

The vestment period and fixed cost make DB pensions unattractive to short-term employees. However, there is an additional mechanism embedded in pension contracts that attach a worker to a firm. Benefits tend to be tied to tenure and wage in the last years of employment, Blake (2006). The schedule of earned benefits over tenure is displayed in table 2. DB plans may cross-subsidize workers with long tenure at the expense of those with short tenure, Friedberg and Turner (2010). This paper will explore the importance of this feature by comparing results to an environment with no cross-subsidization.

Table 2: Value of Pension Benefits as a Proportion of Salary

Year of employment	Present value of new benefits earned (%)	Value of accrued benefits (%)
1	0.32	0.32
10	0.98	6.88
20	3.10	32.58
30	9.18	115.68
40	26.08	365.14

Source: Blake (2006).

Why are pensions more attractive than individual annuities in the first place? Recently, the rise of individual annuities has become widely researched. Pashchenko (2010), for example, tries to account for the under-annuitization. Theoretically, all agents should fully annuitize their savings, see Davidoff et al. (2005), yet annuities are purchased by very few. The model will show that defined benefit pensions are not subject to the same friction that plagues the individual annuity market. Information about earnings allows employers to pool agents of a similar earnings class with the same quantity-price contract. In the private market, high-risk (long-lived) agents will purchase more insurance than low risk (short-lived) agents, driving up the price. Further, low-risk agents can "cash out" their annuity early in retirement, while pensions are illiquid.[1]

The model is constructed to answer the following questions. Can the cost of insurance combined with decreasing tenure rates account for the fall in defined benefit pension prevalence? Has the increase in insurance costs contributed to the decline? How much of the movement away from defined benefit pensions can be accounted for by the delayed-compensation structure of the contract? The model is introduced in the next section. The calibration is discussed, and the paper will conclude with results and implications for future work.

2 Model

Finitely-lived agents will have one job offer arrive every period during their working life. They may keep their old job or accept the new one. When an agent takes a new job, he makes a decision over compensation. he may accumulate defined benefit promises from his employer and recieve a wage, or receive a wage only and save in an annuity through a competitive market. The DB pension promises a fixed payment in retirement, every year, until the agent dies. The account is illiquid; an agent can never cash out his pension. This characteristic of DB pensions serves to evade some adverse selection effects post-retirement. The alternative annuity savings option is perfectly liquid. Purchases of any quantity of the one-period contract may be made, as in Hong and Ríos-Rull (2007). In practice, there are two types of annuities: variable annuities which serve as savings before retirement and pay out a lump sum, and immediate annuities which are purchased lump-sum and provide payments in retirement. When annuitants cash out an annuity early there are fees and tax penalties. Cashing out is a source of revenue for annuity providers, but also drives up the price of annuitites, as shorter-lived annuitants do not roll their variable annuities into immediate annuities, or do so, but cash out early. This is post-retirement adverse selection.

[1]The problem is available in detail in the online appendix, or upon request.

Also important for pricing is the contribution amounts made before retirement. The amount of DB promises accumulated through a firm over time is the same for all employees. High-survival types cannot accumulate more promises than low-survival types at the same firm over the same period. This is not true with individual annuities. High survival agents may purchase larger quantities, driving up the price, so that even at the start of retirement, the return to a pension will be higher than than the return on annuities. This is pre-retirement adverse selection.

In pratice, investment risk falls on the employer in the case of a defined benefit pension, and on the employee in the case of an annuity. This paper abstracts from investment risk. Production will be a function of labor and firm-specific productivity only. Returns to pension funds and annuities will be a function of the weighted survival probabilities of pensioners and annuitants respectively.

The model will include default risk. Firms have the benefit of delaying payment from working years to later on when the worker retires. However, with some probability the firm will default on promises. To purchase insurance against firm default, as mandated by law, employees will pay the expected fee upfront during their first period of employment. They will not accumulate any pension promises until their second period of employment with the firm, making the first period the "vestment period" usually observed in practice with DB pensions. U.S. law requires a firm to pay the fee every year until the pension obligation is fulfilled. In the model, this fee will be paid lump sum, and will be a function of the expected lifetime of the employee. For this reason, DB pensions of new, young employees will be more expensive than DB pensions of new, older employees.

In practice, there are many types of pensions and even hybrids. All defined contribution plan decisions fall on the worker. How much to invest in risky assets versus safe assets? How much to contribute each period? Should I borrow from my 401(k) to pay off my credit card bill? The savings option in the model will be relatively simple: an agent is able to invest in a perfectly liquid annuity. That is, each period the savings account will pay a return of the inverse of the weighted average survival probability of annuitants.

2.1 Environment

Workers are finitely lived, and heterogeneous with respect to their survival probabilities. They may live up to age $t = T$. Survival type π^i is private information. All workers retire at the same age $t = R$. They accumulate savings s for retirement, and may have a pension plan accumulating promises for future retirement payments. The retirement payment is a function of the total pension savings p accumulated during the worker's tenure at the firm. Survival probability will be one before retirement for all types, that is, $\pi_t^i = 1 \; \forall \; i, t < R$. An agent's unconditional probability of surviving to some age t^* is

$$\pi_{t^*}^{iu} = \prod_{t=R}^{t^*} \pi_t^i.$$

This makes the expected lifetime of an agent

$$\ell^i = \sum_{t=R}^{T} \pi_t^{iu}.$$

The annual pension payment once a worker retires is p_R/ℓ^p, where ℓ^p is the average expected retirement life of a pension holder. The conditional survival probability for a pension holder for any period t, π_t^i, is determined from the relative quantity of pension claims held by low and high survival agents. Let p_t^i be the pension claims held at date t by survival types $i = L, H$.

$$\pi_t^p = \frac{p_t^L \pi_t^L + p_t^H \pi_t^H}{p_t^L + p_t^H}$$

The period return to a pension is $R_t^p = (\pi_t^p)^{-1}$. Similarly, the period return to savings (individual annuities) is $R_t^s = (\pi_t^s)^{-1}$. If s_t^i is the savings of agents of type i at time t, the expected period survival probability of an annuitant is

$$\pi_t^s = \frac{s_t^L \pi_t^L + s_t^H \pi_t^H}{s_t^L + s_t^H}.$$

The return to both pension accumulation and savings is a function of the average weighted survival probabilities of the agents demanding each asset. The greater the demand of an asset from a high-survival types relative to low-survival types, the higher the price, or the lower the return.

A worker's value in retirement will depend on his survival type i, his pension p_t, and the balance of his savings s. For all $t \geq R$:

$$V_t^i(p_t, s_t) = \max_{s_{t+1}} U\left(\frac{p_t}{\ell^p} + R_{t-1}^s s_t - s_{t+1}\right) + \pi_t^i V_{t+1}^i(p_{t+1}, s_{t+1}) \tag{1}$$

$$\frac{p_t}{\ell^p} + R_{t-1}^s s_t \geq s_{t+1} \geq 0 \tag{2}$$

$$p_{t+1} = p_t$$

The retiree makes a savings decision each period. Pensions cannot grow after retirement so $p_{t+1} = p_t \ \forall \ t \geq R$. The fixed pension payment is p_R/ℓ^p, and the agent decides how much to save and consume. No borrowing is permitted. Workers can live up to age T, giving the terminal condition

$$V_T^i(p_T, s_T) = U\left(\frac{p_T}{l^p} + R_{T-1}^s s_T\right). \tag{3}$$

Workers could have one to several employers over their working life. Firms are also finitely lived; they face a constant probability of dying δ every period. If a firm dies, any employees are separated from their job, and the firm defaults on all pension promises. For this reason, policy requires firms to insure pensions. An employer who offers a pension plan to an employee must pay a fixed insurance cost I. If the firm dies before the worker does, the insurance company takes over the pension payments. When a firm dies, another firm, identical to the last, takes it's place. Firms are heterogeneous with respect to their period profit per worker, θ, distributed discretely and uniformly over $(\underline{\theta}, \overline{\theta})$. There are N firm types so the p.d.f. of firm profit is

$$P(\theta = \theta^n) = 1/N \ \ \forall \ \theta^n.$$

Workers may also leave their job endogenously if a better wage offer comes along.

The combination of endogenous and exogenous separation will determine the average expected tenure of an employee at a firm. Workers enter the model ready to work. All workers have a single job opportunity arriving at the beginning of each period. A constant returns to scale technology in labor allows firms to hire as many workers as they can be matched with. Workers randomly match with firms. There is no utility from unemployment, so agents will always be employed. When a worker is not separated he has the option of sticking with his old job or taking the new offer. When a worker is separated from his job exogenously (the firm dies), he has to start at the beginning of the wage distribution $\underline{\theta}$.

Workers have a choice of how to be compensated. They could take a wage only, equal to their marginal product, $w = \theta$. They could also choose to take a wage, $w = (1 - \psi)\theta$, and accumulate a pension. If they opt for a pension, each period after the vestment period, their pension grows by $\xi_\tau \psi \theta$. The fraction of earnings forgone each period for the pension, $\psi \in (0, 1)$, is the same across all firms. $\xi_\tau \in \mathbb{R}$ represents the amount of cross-subsidization from new workers to tenured workers, and is also the same across firms. Tenure type is given by $\tau \in (1, R - 1)$. In the baseline model, $\xi_\tau = 1 \ \forall \ \tau$. Vestment is the first period after the worker accepts the new job with the pension. Instead of accumulating pension promises, the worker pays a fixed insurance cost I. Take-home wage will then be a function of the worker's job decision and pension decision. He can take the new job or not, and if he does take it, he decides on whether to accumulate a pension or not. The indicator $q_t = 0, 1$ will describe an agent's pension policy decision. $q_t = 1$ when the agent decides to take the pension option from a new job, or he is keeping an old job with which he is pensioned.

The worker makes up to three decisions each period. After deciding on job placement, and compensation, the worker decides how much to save. Figure 2 summarizes the timing within a period. At the start of the period, the worker finds out if he has been exogenously separated from the firm. Let x_t be an indicator for separation. If $x_t = 0$, the worker was not separated from his job. If $x_2 = 1$, he was separated and must start at the bottom of the wage distribution with $\underline{\theta}$. Agents

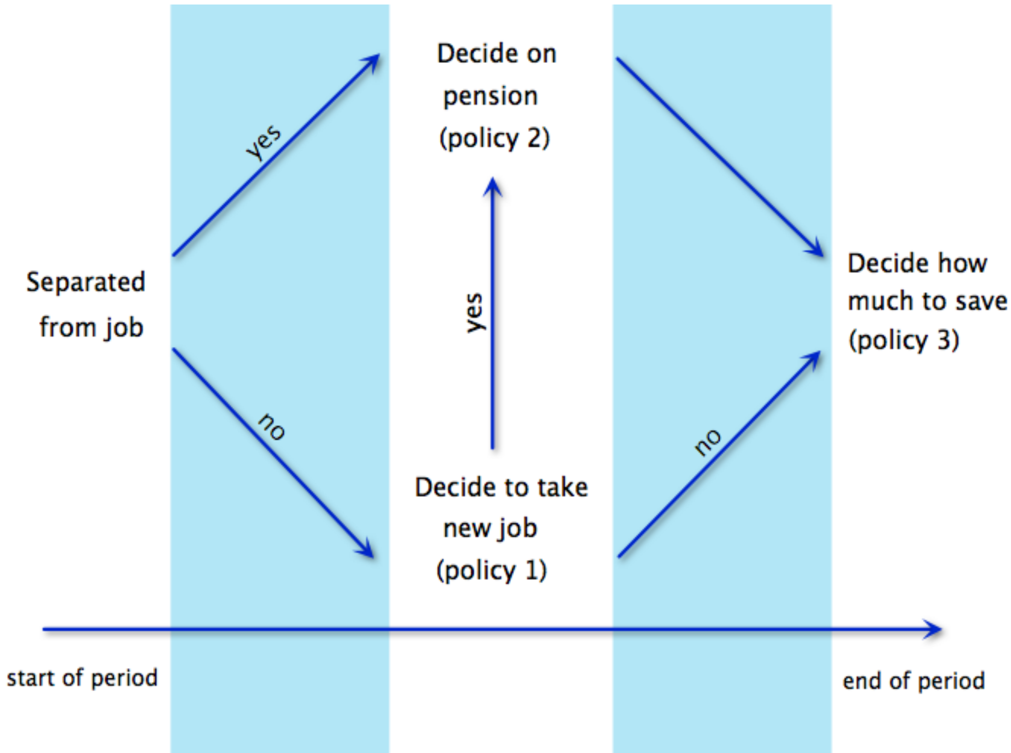


Figure 2: Timing

who were not separated are randomly matched with a firm. Workers taking a new job must make two decisions: whether to take a pension, and how much to save. If a worker was not separated and decides to stick with his old job, he only needs to decide how much to save.

The value from sticking with job θ_{t-1} is W_t, and the value from a new job θ_t, is X_t. With probability δ a worker will be exogenously separated from his job, and forced to take a job with productivity $\underline{\theta}$. With probability $(1-\delta)$ he will get to choose: $\max\{W_t, X_t\}$. Given q_t, x_t, W_t and X_t, the wage schedule is described in equation 4. Wage will be a function of the agent's pension choice $q_t = 0, 1$.

$$w_t(q_t) = \begin{cases} \theta_{t-1} & \text{if } q_t = 0 \text{ and } W_t > X_t,\ x_t = 0 \\ \theta_t & \text{if } q_t = 0 \text{ and } X_t > W_t,\ x_t = 0 \\ \theta_t - I & \text{if } q_t = 1 \text{ and } X_t > W_t,\ x_t = 0 \\ (1-\psi)\theta_{t-1} & \text{if } q_t = 1 \text{ and } W_t > X_t,\ x_t = 0 \\ \underline{\theta} & \text{if } q_t = 0,\ x_t = 1 \\ \underline{\theta} - I & \text{if } q_t = 1,\ x_t = 1 \end{cases} \tag{4}$$

The full expression of W_t is below. The value to a worker of survival type i of staying with his current job depends on his current savings, s_t, pension account balance p_t, whether he is pensioned $q_t = 0, 1$, his tenure τ, and his wage θ_{t-1}. His value next period V_{t+1} depends on future wage offers, as well as all of the variables just listed. Pension promises accumulate by $\xi_\tau \psi \theta$ if he is vested. If he did not choose a pension when he accepted the job, the pension grows at the rate of return on pension funds R_t^p. Like savings, the period return is the inverse of the average weighted survival probability of the agents holding the asset. Before retirement, $R_t^p = R_t^s = 1 \ \ \forall\ t < R$.

$$\begin{aligned} W_t^i(s_t, p_t, q_t, \tau, \theta_{t-1}) = \max_{s_{t+1}} & \, u(w_t + R_{t-1}^s s_t - s_{t+1}) \\ & + \frac{\pi_t^i}{N} \sum_{\theta_{t+1}} V_{t+1}^i(s_{t+1}, p_{t+1}, q_{t+1}, \tau + 1, \theta_{t-1}, \theta_{t+1}) \end{aligned} \tag{5}$$

$$w_t(q_t) = \begin{cases} \theta_{t-1} & \text{if } q_t = 0 \\ (1-\psi)\theta_{t-1} & \text{if } q_t = 1 \end{cases}$$

$$p_{t+1} = \begin{cases} R_t^p p_t & \text{if } q_t = 0 \\ R_t^p (p_t + \xi_\tau \psi \theta_{t-1}) & \text{if } q_t = 1 \end{cases}$$

$$w_t(q_t) + R_{t-1}^s s_t \geq s_{t+1} \geq 0$$

$$q_{t+1} = q_t$$

If the worker takes the new job with productivity θ_t, his value is X_t, and he must choose compensation $q = 0, 1$, in addition to savings. X_t also depends on his current amount of savings s_t and pension p_t. His value next period is a function of his savings, pension, pension status, tenure of one year, the wage he took with this job, θ_t and the offer that arrives next period θ_{t+1}.

$$\begin{aligned} X_t^i(s_t, p_t, \theta_t) = & \max_{q_t, s_{t+1}} u(w_t + R_{t-1}^s s_t - s_{t+1}) \\ & + \frac{\pi_t^i}{N} \sum_{\theta_{t+1}} V_{t+1}^i(s_{t+1}, p_{t+1}, q_{t+1}, 1, \theta_t, \theta_{t+1}) \end{aligned} \tag{6}$$

$$w_t(q_t) = \begin{cases} \theta_t - I_t & \text{if } q_t = 1 \\ \theta_t & \text{if } q_t = 0 \end{cases}$$

$$p_{t+1} = R_{t-1}^p p_t$$

$$w_t(q_t) + R_{t-1}^s s_t \geq s_{t+1} \geq 0$$

$$p_0 = s_0 = 0$$

$$q_{t+1} = q_t$$

A worker who has been separated from his job will have value $X_t^i(s_t, p_t, \underline{\theta})$ where the wage schedule is given by

$$w_t(q_t) = \begin{cases} \underline{\theta} - I & \text{if } q_t = 1 \\ \underline{\theta} & \text{if } q_t = 0. \end{cases}$$

The expected value of a worker at the beginning of period t is then

$$\begin{aligned} V_t^i(s_t, p_t, q_t, \tau, \theta_{t-1}, \theta_t) = (1-\delta) \max\{W_t^i(s_t, p_t, q_t, \tau, \theta_{t-1}), X_t^i(s_t, p_t, \theta_t)\} + \\ \delta X_t^i(s_t, p_t, \underline{\theta}). \end{aligned} \tag{7}$$

3 Calibration

Most of the parameters can be estimated directly from data, such as survival probability and insurance cost. Expected job tenure at a new job is important for the pension decision, and is available through the BLS. This will depend on both the exogenous rate, δ, and endogenous separation, when $X > W$. The exogenous separation rate, δ, will be calibrated so that the model produces average tenure rates that match those reported by the BLS for men in 1992 and 2006 respectively. If age groups are given the same weight in the data, as they are in the model, then average tenure in 1992 is 8.5 years, and drops to 6.9 years in 2006.

Table 3: Wealth of a Typical Household Approaching Retirement (55-64), 2007

Source of Wealth	Amount ($)	% Total
Primary house	$138,600	20
Business assets	15,900	2
Financial assets	29,600	4
401(k)/IRA	50,500	7
Defined benefit	122,100	18
Social security	298,900	44
Other assets	21,000	3
Total	676,500	100

Source: Munnell et al. (2009).

Table 3 provides a breakdown of defined benefit pension as a fraction of total retirement wealth. The model will ideally produce pension accumulation that matches not only match the trend from figure 1, but also the ratios described in table 3. One important source of retirement income not yet discussed is social security. Table 3 shows that it accounts for 44% of average retirement income, Munnell et al. (2009). As social security is a form of longevity insurance, it is important to include it in the model. In the US, all workers get taxed at the same rate, that is, the employee faces a 4.2% tax rate and the employer a 6.2% rate. Benefits depend on average earnings, but are progressive. A worker in the bottom half of the earnings distribution can expect about half of his wages to be replaced, while that ratio is much smaller for a worker on the upper half of the distribution. To add social security taxes to the model, the wage distribution is inflated so that the after-tax income still falls between 0 and 1. More on the social security benefit function is available in appendix A.

In order to produce a wage distribution similar to that of the US, workers are divided into productivity classes $c = 1, \ldots, C$. Instead of receiving a wage shock drawn from the $\theta \in (0, 1)$ distribution, each worker will draw from a distribution which is a subset of θ. Weights are put on each class to correspond to the ratio of US workers in that income class. The three income classes are divided as $\theta_1 \in (0, .25)$, with weight 0.57, $\theta_2 \in (.25, .5)$,with weight 0.30 and $\theta_3 \in (.5, 1)$ with weight 0.13. More detail is available in appendix A.

Table 4 describes the parameters. Insurance cost has been normalized for the $(0, 1)$ wage distribution. With equal measures of high and low-survival agents, the 1992 expected lifetime is about 77 years. Workers enter the model at age 24, work until retirement at age 62, and then consume from savings, pension and social security payments until they die. The maximum age an agent may live is 102. Changes in insurance costs, separation rates and survival probabilities from 1992 to 2006 will all be considered.

The insurance cost is reported as the fee per 2-year period, rather than as a lump sum amount because the cost will depend on a worker's age. Firms will have a financial obligation for much longer if a new hire is young than if the new hire is near retirement. The new hire will pay a fixed cost for a DB pension equal to the annual cost times their remaining expected years of life. This cost is 5.1% of the median annual salary for a 30-year old hire in 1992. It is 7.4% of the median annual salary for a 30-year old hire in 2006. However these costs are only 3.0% and 4.5% of median salary for a 50 year-old new hire in 1992 and 2006 respectively.

More detail is avaiable in appendix B.

Table 4: Parameters

Symbol	Description	Value
	wage class 1	(0,0.25)
θ	wage class 2	(0.25,0.50)
	wage class 3	(0.50,1.00)
λ	class weights	(.57,.30,.13)
π^L,π^H	'92 2-year survival probability	0.880, 0.900
	'06 2-year survival probability	0.900, 0.935
	first working age	24
R	retirement age	62
T	maximum age	102
γ	risk aversion	0.85
ψ	fraction of wage contributed to pension	0.14
i	'92 insurance cost[a]	0.000324
	'06 insurance cost	0.000452
ξ	cross-subsidization	1[b]
δ	'92 separation rate	0.0475
	'06 separation rate	0.1000

[a] Insurance costs are per 2-year period.
[b] For the baseline model only.

The amount of wage forgone for pension accumulation is $\psi = 0.14$. Gustman et al. (1994) look at a nationally representative data set of workers with defined benefit pensions and found the average present value of pension wealth came to about $180,000 in 1992 dollars. This quantity is 14% of the cumulative discounted value of earnings from hire to retirement age. Table 4 describes the parameters used in the model for each calibration. δ is calibrated to match BLS average tenure statistics for 1992 and 2006. The other parameters (besides γ) are estimated directly from data. Risk aversion γ was chosen to be within the standard range for utility given by

$$U(c) = \frac{c^{1-\gamma}}{1-\gamma}.$$

4 Results

4.1 Baseline Model

The baseline model abstracts from any cross-subsidization from low-tenure employees to longer-tenured employees. Every worker earns his marginal product each period, $\xi_\tau = 1 \ \forall \ \tau$. The first exercise finds the separation rate δ to match average tenure for 1992. Results are reported as the 1992 calibration. The first experiment changes only the separation rate to get average tenure observed in 2006. This will isolate the effect from increased job turnover. The second experiment increases insurance cost in addition to to turnover. The last calibration increases separation, insurance cost and survival probability to 2006 levels, and is reported under the 2006 calibration.

Table 5: Tenure

	δ	i	$\bar{\pi}_R$	Average tenure	Average tenure of pensioners	Average tenure (no pension)
1992	0.0475	0.000324	0.8900	8.6	12.8	7.6
Exp 1	0.1000	0.000324	0.8900	6.8	7.6	6.7
Exp 2	0.1000	0.000452	0.8900	6.8	8.2	6.7
2006	0.1000	0.000452	0.9175	6.8	8.2	6.8

Table 5 shows the results for tenure from increasing the separation rate from 0.0475 to 0.1000. Separation rates were chosen to produce the average tenure rates for 1992 and 2006 reported by the BLS. These rates correspond to a 4.75 and 10.0% probability of being exogenously separated from the current employer over each two-year period. Average tenure drops from 4.3 to 3.4 periods (8.6 to 6.8 years). Tenure drops not just because of exogenous separation, but because endogenous separation increases as well. Average tenure for a pensioned employee is higher because he has paid a fixed cost for the pension. When fewer employees take pensions under experiment 1, they are more likely to switch jobs when a better offer comes along. The second experiment shows that workers who have to pay a higher fixed cost for the pension tend to stay with the job longer. There is not a significant change from increasing survival probability.

Table 6: Model Predections: % of Workers aged 51-61 with Pension

	Data	Model
1992	27	27
2006	14	10
% drop	48	63

Figure 1 from the introduction reports the number of 51-61 year olds who had a pensioned job at the time of interview. Table 6 compares these data from the HRS to model predictions for the same age cohort. The model matches the 1992 levels well, but overpredicts the fall in pension prevalence. This may be because the basline model does not attach as much of a tenure reward as a defined benefit pension in practice. The extension in the next section explores this aspect of the contract.

Table 7 shows the fraction of agents with a pension drops from 52.8% in the 1992 calibration to 20.2% in experiment 1, a 62% decline, confirming that expected tenure is important for the pension decision under this environment. When higher insurance costs are accounted for, the percent of pensioners falls to 18.52%, resulting in a 65% decline.

An increase in survival probability (2006 calibration) causes the number of high earnings class workers with positive pension wealth to rise from experiment 1 and 2, but middle class pensioners decline. Figures 3 and 4 may explain this behaviour. Under the 1992 calibration, pensions offer a consistently higher return than annuities. Returns increase under experiment 1, but pensions are still consistently cheaper than annuities. However, under the new survival probabilities, not only levels, but relative prices change quite a bit. The returns to the two assets start at about the same level at retirement. Only after low-survival types start selling back thier annuities after retirement does the pension offer a higher return. Because the adverse selection is worse in the 2006 calibration, many middle class workers find the fixed cost of the pension too high. The high earnings types are less bothered by the fixed cost; they are more concerned with a longer potential retirement life, increasing their demand for longevity insurance.

Table 7: % with Positive Pension Wealth at Retirement

	1992	Exp 1	Exp 2	2006	% change
class 1	34.3	0.0	0.0	0.0	-100.0
class 2	72.9	39.5	34.6	19.9	-72.7
class 3	87.3	63.4	61.8	75.9	-13.1
total	52.8	20.2	18.5	18.6	-64.8
data (DB only)	39.0			24.0	-38.5
data (DB&DC)	70.0			51.0	-27.1

The model overestimates the number of workers with a defined beenfit pension, and the decline from 1992 to 2006. The model predicts a 65% decline in pensioners, while the data reports a 46% decline, Gustman et al. (2010). The increase in separation rate affects the lower earnings class disproportionately more than the other two. With a higher separation rate, no agents from the lowest earnings classes take a defined benefit pension, even though 34% were pensioners before.

The middle earnings class saw the number of pensioners decrease by 42% and the highest earnings class experienced a 27% decline under experiment 2. The expected benefit from taking a defined benefit pension is too low for low earnings workers to justify the payment of the fixed insurance cost.

When insurance cost is increased in experiment 2, the present value of the mean pension increases for middle class. The present value of the mean pension remains unchanged for the high-earnings class, but slightly fewer of them take the pension. The middle class only take the pension when the benefits have a longer time to accumulate, and are less likely to leave a pensioned job. The richer agents are not bothered to change their turnover behaviour, but they will decline a pension if they suspect a very short tenure with a firm.

The pension value as a fraction of total retirement wealth is larger for the higher earnings classes, see 8. The model predicts 1992 values rather closely. According to the HRS, pensions account for about 30% of retirement wealth for househols households with positive pensions wealth. The model predicts an average of 28%. The model predicts too much change in the mean pension in 2006 however. The value of the mean pension changed little in the data, falling only to 28%. The model predicts a fall to 8%.

Table 8: Present Value of Mean Pension as % of Mean Retirement Wealth

class	1992	Exp 1	Exp 2	2006
1	26	0	0	0
2	28	19	20	18
3	34	25	25	20
total	28	9	9	8

Savings fell or remained the same for all three classes with an increase in separation. Table 9 shows pension, savings and social security welath per capita at retirement. Workers start at the bottom of the wage distribution following an exogenous separation, implying that the environment with higher separation forces more workers to the bottom of the earnings distribution for at least one period, decreasing average earnings, and ultimately decreasing retirement wealth.

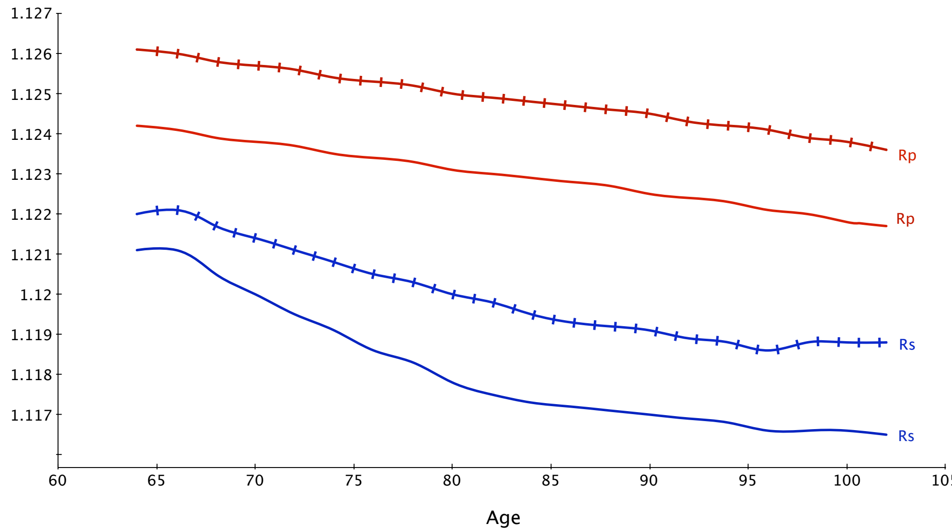
Table 9: Wealth Sources as % of Mean Retirement Wealth

	class	1992	Exp 1	Exp 2	2006
PV pension	1	9	0	0	0
per capita	2	20	7	7	4
	3	30	16	15	15
Savings	1	21	20	20	21
per capita	2	20	23	24	27
	3	30	33	33	37
PV Social	1	70	80	80	79
Security	2	60	70	70	69
	3	41	51	51	49

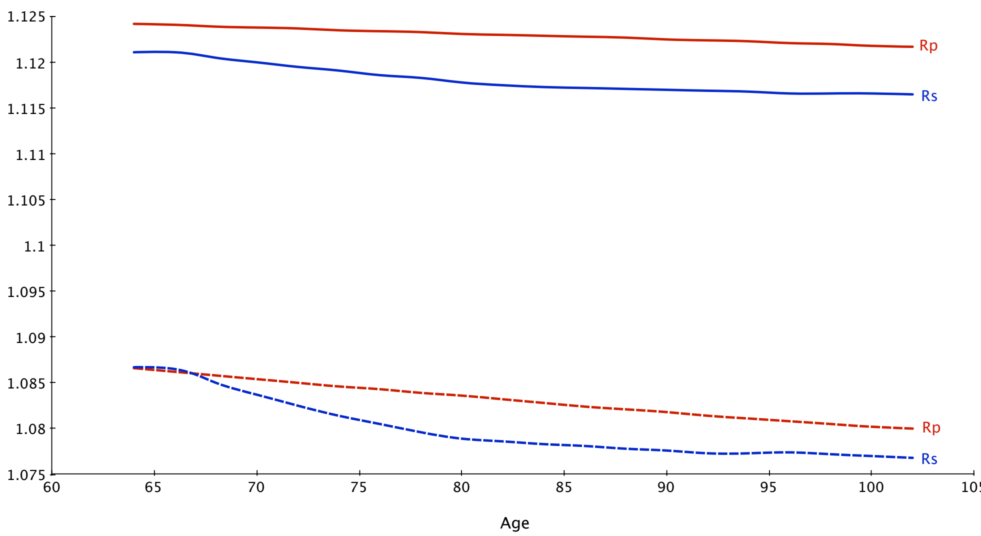
There are two reasons pensions suffer less from adverse selection. First, the amount invested in the pension, 14% of earnings, is the same for both survival types. Second, both survival types run down their pension at the same rate because it is illiquid and the payment function is fixed. With the annuity, high survival types may invest more before retirement, and low survival types may "cash out" much of the asset early on in retirement. Pensions are not free of adverse selection however. The low types may decide not to take a pension. If only high survival agents accumulate pension, the return would be less than savings. Under both environments, pensions provide a higher return, and both survival types are taking pensions despite the fixed insurance cost.

The period return on the two assets through retirement is shown in figure 3. The solid lines are asset prices under the 1992 calibration and the hashed lines are asset prices under experiment 1 (increased separation rate). The period return to a pension is higher than the annuity because it suffers less from adverse selection. Asset prices under the second environment, with higher turnover and less pensioners, are higher. Under the first environment, some low-earners took pensions, but they were disproportionately high-survival types. After separation rate increased, pensions did not look attractive to any of the low-earners. The ratio of high-to-low survival types among the middle and high-earners was not as high as the low-earners, and a more even balance of types allowed for a lower price, or higher return in the second environment.

Figure 3: Asset Returns



(a) 1992 and Experiment 1



(b) 1992 and 2006

4.2 Extension: Contract with Tenure Rewards

Table 2 from the introduction gives evidence for strong cross-subsidization from low-tenure workers to longer-tenured workers. Every ten years the present value of new benefits earned per year increases threefold. The model from the previous section overpredicts the fall in DB plans. This could be because the increase in separation rate needed to generate the fall in expected tenure is too large. In the previous environment, pensioned workers are not as attached to their employer as they will be under tenure rewards. This section asks how do these additional tenure incentives change pension decisions with an increasing separation rate?

In this environment ξ_τ is a non-linear increasing function of τ, shown in table 10. From 2 - 12 years the fraction of forgone earnings that translate into pension promises from the employer increase from 0.25 to 0.75, an increase of a factor of 3. From 12 to 22 years ξ increases again to 2.25, an increase of 3 times. Finally, ξ increases to 6.75 by 32 years of tenure, another increase of 3 times. Should a worker obtain tenure for over 30 years, the benefits are substantial. However, a worker who is let go within 15 years of tenure loses quite a bit of compensation.

Table 10: Tenure Rewards

τ	1	2	3	4	5	6	7	8
tenure	2-3 years	4-5	6-7	8-9	10-11	12-13	14-15	16-17
ξ_τ	.25	.35	.45	.55	.65	.75	1.05	1.35
τ	9	10	11	12	13	14	15	16
tenure	18-19	20-21	22-23	24-25	26-27	28-29	30-31	32+
ξ_τ	1.65	1.95	2.25	3.15	4.05	4.95	5.85	6.75

The change in tenure from the increase in separation rate can be seen in table 11. To meet the decline in average tenure, the separation rate was increased by 68% for the tenure rewards environment. The difference between the average tenure of pensioners and non-pensioners is much larger than the baseline case. The increase in pension tenure is due to the incentives of the contract. The decrease in non-pension tenure is due to the number of productivity types. The baseline model had only 8 firm productivity types per earnings class, but the extension has 12, increasing endogenous tenure. The tenure distribution by pensioned matches and non-pensioned matches can be seen in figure 5.

Table 11: Tenure

	δ	Average tenure	Average tenure of pensioners	Average tenure (no pension)
1992	0.0550	8.6	17.4	6.5
2006	0.0925	6.8	15.5	6.4

Table 12 compares results from both e extension and the baseline model to the data. The extension also overpredicts the decline in pensions of workers approaching retirement, and even more so than the baseline model. The extension predicts that the number of agents approaching retirement actively contributing to a DB pension falls 72%.

Table 12: Model Predections: % of Workers aged 51-61 with Pension

	Data	Baseline Model	Tenure Rewards
1992	27	27	25
2006	14	10	7
% drop	48	63	72

The model with tenure rewards does better at predicting the number of agents with any positive defined benefit pension wealth at retirement. The model predicts 58% of agents entering retirement with positive DB pension wealth. The data predicts a range of 39-70% (see table 7). However, the data predicts a drop of only 27-39%, while the model predicts a drop of 71%.

Table 13 shows the change in the percent of retirement wealth provided by pensions for households who have accumulated pensions. Unlike the baseline model, the extension predicts less of a decline in the value of the mean pension. In this respect, tenure rewards does a better job of modelling the micro behavior: fewer workers take pensions, but those who do, try to stay with the employer long enough to accumulate substantial benefits. The extension overpredicts the size of pensions in 1992 however. The data predicts mean pensions to be about 30% of retirement wealth.

Table 13: Present Value of Mean Pension as % of Mean Retirement Wealth

class	1992	Exp 1	2006
1	47	44	35
2	47	45	35
3	56	55	43
total	48	46	36

It is easy to see the substitution away from pensions towards savings in table 14. Social security is increasing as a percent of retirement wealth because workers are entering retirement with less retirement wealth in 2006. This is due to two reasons: longevity insurance is more expensive due to worse adverse selection, and higher separation rates means more workers are bumped to the bottom of the wage distribution decreasing average lifetime earnings.

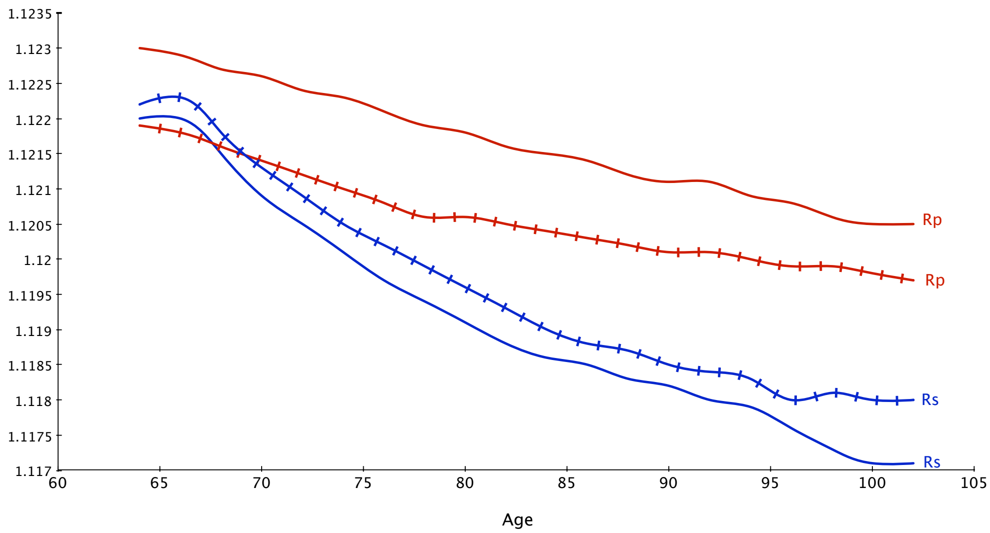
Adverse selection works differently under tenure rewards than the baseline model. Figure 4 first shows the returns from 1992 and the first experiment, where only separtion rate is increased. In the baseline model, returns increased because the high survival low earnings workers stopped taking pensions. Under tenure rewards, this is not the case. Returns decrease because it is the low survival, low and middle earners that turn away from pensions, and instead save with annuities. This causes annuity returns to increase.

Table 14: Wealth Sources as % of Mean Retirement Wealth

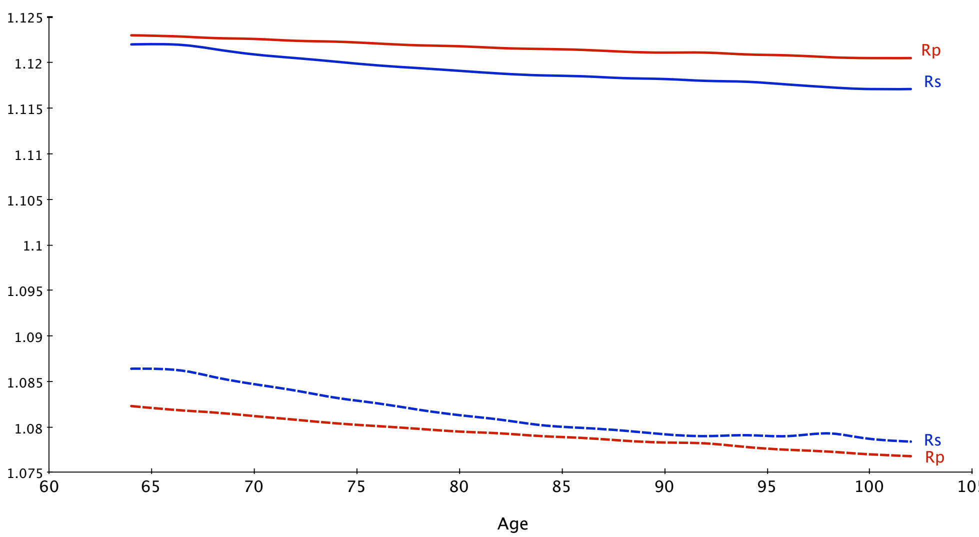
	class	1992	Exp 1	2006
PV pension	1	20	5	3
per capita	2	30	9	7
	3	38	15	14
Savings	1	17	19	20
per capita	2	16	24	26
	3	24	36	37
PV Social	1	63	76	77
Security	2	54	67	67
	3	38	49	49

The 2006 calibration differs from the baseline model in another way. Under the 2006 calibration, in the baseline model, returns to pensions were about the same as annuities at retirement, but quickly surpassed them as adverse selection changed the pool of annuitants. Under tenure rewards, annuities always have a higher return than pensions. The new survival probabilities cause many low survival types to abandon the pension for the annuity. This may be because the variance in survival probability is higher under the 2006 calibration. One might ask why the agents would take the pension at all, and the answer lies in the very generous pension rewards should an agent acquire tenure of more than 15 years.

Figure 4: Asset Returns

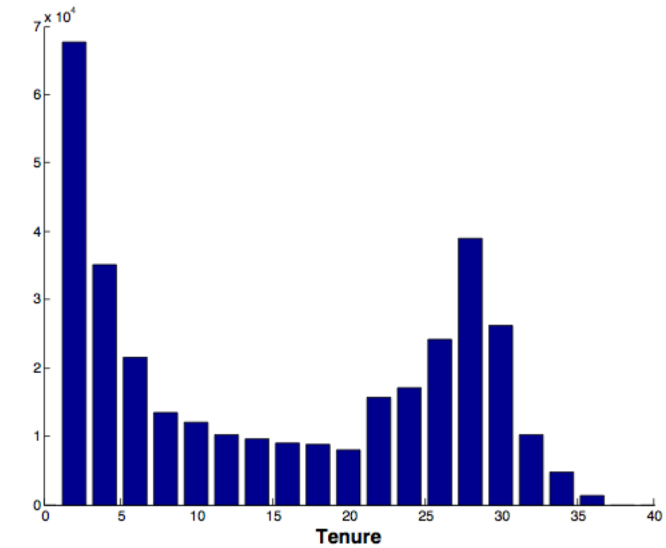


(a) 1992 and Experiment 1

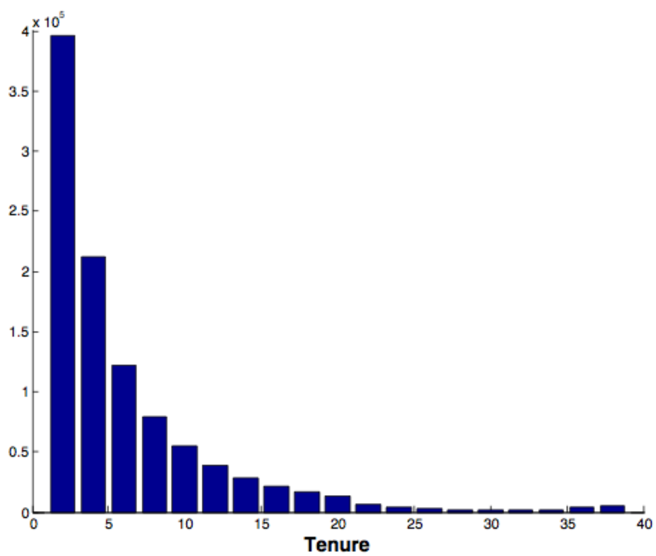


(b) 1992 and 2006

Figure 5: Histogram of Worker Tenure in 1992 by Pension Type



(a) Pensioned



(b) No Pension

5 Conclusion

This paper has highlighted the role adverse selection plays in making defined benefit pensions more attractive than individual annuities. Individual annuities suffer more from adverse selection because they are not as illiquid as pensions, and because quantity pooling cannot occur. As the market for defined benefit pensions becames thin, the adverse selection effect grows worse, and the return on defined benefit pensions, relative to annuities, falls. This adds to the movement away from defined benefit pensions. The decline is worrysome because individual annuities are not replacing DB pensions one-for-one as they dissappear from retirement wealth. This has resulted in a decline in longevity insurance over the last couple decades.

One of the possible explanations for the switch from defined benefit to defined contribution pensions is declining job tenure. This mechanism was tested by setting exogenous separation rates, so that when combined with endogenous separation, would produce average tenure observed among US workers in 1992 and 2006. Also considered are the higher fixed costs of DB pensions, and increased survival probability. These produce little change in pensions, especially relative to the change induced by the change in separation rate. While the baseline model matches the level of pensioners in 1992, it overpredicts the fall, predicting too few pensioners in 2006.

The extension accounts for the cross-subsidisation from low-tenure workers to long-tenure workers observed in DB pension contracts. Pension decisions become more tenure-sensitive in this environment, and a smaller change in separation rate is necessary to match the decline in average tenure. The tenure rewards environment also overpredicts the fall in pension prevalence, but does a better job at matching micro-level trends. This suggests that the model might be over-relying on exogenous turnover relative to endogenous turnover. The next experiment will increase the number of productivity types per earnings class so that a greater ratio of turnover will be endogenous. If this does not result in a smaller decline in pensions, the answer to the question posed in the title of this paper might lie elsewhere.

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A Income and Social Security

The US Census Bureau reports an earnings distribution for men in 2010 as shown in table 15. The formula used by the SSA is shown in below. If E is annual earnings, social security benefits are b.

Table 15: Full-Time Male Earnings Distribution 2010

Earnings	Percent	Cumulative
<$25,000	23.8%	23.8%
$25,000-49,999	33.4%	57.2%
$50,000-74,999	20.9%	78.1%
$75,000-100,000	9.5%	87.6%
>$100,000	12.4%	100.0%

Source: US Census.

$$b = \begin{cases} .9*\text{E} & \text{if } E < 8,998 \\ .9*8998 + (\text{E-}8,998)*.32 & \text{if } 8,998 < E \leq 54,204 \\ .9*8998 + (54,204\text{-}8,998)*.32 + (\text{E-}54,204)*.15 & \text{if } 54,204 < E \leq 106,800 \\ .9*8,998 + (54,204\text{-}8,998)*.32 + (106,800\text{-}54,204)*.15 & \text{if } E > 106,800 \end{cases}$$

Period earnings θ are distributed $(0,1)$. There are three income classes, which are divided as $\theta_1 \in (0, .25)$, corresponding to earnings $< \$50,000$, $\theta_2 \in (.25, .5)$, corresponding to earnings between $\$50,000$ and $\$100,000$ and $\theta_3 \in (.5, 1)$ corresponding to earnings greater than $\$100,000$. The three classes have the following population weights, taken from table 15: $\lambda = (.57, .30, .13)$. To calculate social security benefits for each period in retirement, earnings E in the benefit equation are scaled down by $\$200,000$.

B Fixed Costs and Survival

In 1992 DB pension insurance was a fixed rate of $ 19/year, plus an additional $9 per year per $1,000 underfunded, with a maximum rate of $72 for underfunded plans. As many plans are severely underfunded, the PBGC phased out the maximum rate by 1997. By 2006 the fixed rate had increased to $33/year, and the variable cost remained the same, but without any cap, PBGC (2011).

Table 16: PBGC-Insured Plans by Premium Paid (2005)

Variable Rate per Participant	Plans	% of All Plans
$19 (No Variable-rate)	15,309	51.7
$19.01-$38.99	1,684	5.7
$39.00-$58.99	2,048	6.9
$59.00-$78.99	1,839	6.3
$79.00-$98.99	1,609	5.4
$99.00-$118.99	1,190	4.0
$119.00-$218.99	2,941	10.0
$219.00-$318.99	1,036	3.5
$319 or more	1,949	6.6

Source: PBGC databook (2006).

The following statistics from the PBGC databook 2006 table S-40, shown here in table 16, allow for an estimate of average annual fees. The average annual insurance fee comes to about $69. If we assume the distribution of under-funded firms was similar in 1992, and keeping the cap in mind, we estimate an annual insurance fee of $32 in 1992 dollars ($46 in 2006 dollars).

The formula for computing the fixed cost of the defined benefit plan is

$$FC = i * \mathcal{E}_t[l].$$

It will be a function of age, where $\mathcal{E}_t[l]$ is the expected lifetime of a newly-hired agent of age t, and the annual insurance fee i. Expected lifetime of a 60-year old man has increased: he could expect to live an additional 18.9 years in 1992, and by 2006 he expects to live an additional 20.7 years.[2] The fixed cost of a pension for a newly hired 30 or 50 year-old employee is described below in table 17. The median annual salary for men in 1992 and 2006 in current dollars is \$30,796 and \$47,586 (\$44,346 and \$47,586 in 2006 dollars).

Table 17: Fixed Costs of DB Pension in 2006 Dollars

		Insurance Cost	As % of Median Annual Salary
1992	30 year-old hire	\$2,249	5.1%
	50 year-old hire	\$1,329	3.0%
2006	30 year-old hire	\$3,498	7.4%
	50 year-old hire	\$2,118	4.5%

The cost is probably large enough to deter short-term employees from taking defined benefit pensions. Normalizing the period insurance cost to the $\theta \in (0, 1)$ income distribution

The average period earnings in the model are $\bar{\theta} = 0.3112$. Two-year periods imply annual earnings are 0.1556. The annual insurance cost is \$69 in 2006, which is %0.145 of the median annual salary. So this amounts to $.00145 * 0.1556 = 0.000226$ per year for the 2006 2-year periods economy. The annual insurance cost of \$32 in 1992 was 0.104% of the median annual salary, making the model cost $0.00104 * 0.1556 = 0.000162$ per year.

[2] 1992 lifetables and 2006 lifetables from National Vital Statistics Report.