Pension Costs and Retirement Decisions in Plans that Combine DB and DC Elements: Evidence from Oregon*

John Chalmers
University of Oregon

Woodrow T. Johnson
U.S. Securities and Exchange Commission

Jonathan Reuter
Boston College and NBER

June 30, 2012

Abstract

The Oregon Public Employees Retirement System (PERS) uses benefit formulas drawn from both defined benefit (DB) and defined contribution (DC) pension plans and automatically pays retirees the maximum benefits for which they are eligible. We use PERS administrative data covering January 1990 to December 2003 to study the impact of this hybrid plan design on employers' costs and employees' behavior. We have three broad findings. First, the flexibility built into PERS is costly for employers to provide. The expected present value of the benefits owed to employees retiring under the hybrid plan during our sample period is 57% higher than it would have been under a traditional DB plan. Second, we find that the hybrid plan distorts employees' retirement decisions. The simplest way to demonstrate these distortions is to note that as average retirement benefits increase above the level they would be in a traditional DB plan, average retirement ages fall. We are also able to exploit two sources of exogenous variation in retirement incentives. The first arises from the use of stale returns to calculate retirement benefits between 1990 and 1999. The second arises when PERS incorporates updated life expectancy tables into its benefit formulas effective July 2003, in an effort to reduce the level of underfunding. We find evidence that employees respond to both types of retirement incentives. Third, we find evidence of peer effects in that employees respond more strongly to their own retirement incentives when more of their coworkers face the similar incentives. The retirement waves that result from existing employees seeking to prevent declines in pension benefits are likely to increase the administrative costs associated with pension reform.

* Prepared for "Retirement Benefits for State and Local Employees: Designing Pension Plans for the Twenty-first Century," NBER Conference, August 17-18, 2012, Jackson Hole, WY. We thank employees from the Oregon Public Employees Retirement System who provided invaluable assistance to us in understanding Oregon's pension system and then collecting and interpreting the data, and we thank Guy Tauer from the Oregon Employment Department for his assistance in collecting data. The PERS system underwent major Legislative changes in late 2003 that altered many important characteristics of the system. As we describe in section 6, the pension system available to employees hired after August 2003, is significantly different than the pension system that we describe and analyze in this paper. Parts of this research were supported by the U.S. Social Security Administration through grant #10-P-98363-1-05 to the National Bureau of Economic Research as part of the SSA Retirement Research Consortium. The findings and conclusions expressed are solely those of the authors and do not represent the views of the SSA, any agency of the Federal Government, or the NBER. The Securities and Exchange Commission, as a matter of policy, disclaims responsibility for any private publication or statement by any of its employees. The views expressed herein are those of the authors and do not necessarily reflect the views of the Commission or of its staff.

1. Introduction

Employers must weigh the expected benefits of the pension plans they offer to employees against the expected costs. From an employer's perspective, offering a more generous pension plan has two potential benefits. First, it may allow the employer to attract higher quality employees. Second, it may minimize employee turnover. Governor Tom McCall emphasized both of these potential benefits in 1967, when arguing to reform Oregon's Public Employees Retirement System (PERS):[1]

> "We are in a time of inflation and high employment. I have personal experience with the difficulty of recruiting top quality people at the available salaries and personal knowledge of the real sacrifices made by some who have accepted positions in my administration…. At all levels our state employment has shown heavy turnover. This requires extensive recruiting and training programs and threatens a real loss of competency if not checked…."

The implication was that a more generous pension plan would improve the quality of the services provided by state and local employers and reduce the administrative costs associated with employee turnover. On the other hand, increasing the expected retirement benefit payments imposes a direct cost on employers, who must cover these payments. In addition, attempts to increase (or decrease) expected retirement benefits may impose additional costs on employers through their impact on employee behavior.

PERS was created in 1946 as a simple "money-purchase system," with benefits capped at $125 per month. Between 1946 and 1990, when our sample period begins, PERS became a pension plan with both defined benefit (DB) and defined contribution (DC) elements. As in a traditional DB retirement plan, retirees are eligible to receive life annuity payments based on their salary and years of service. However, employees contribute into a DC-style retirement account with two investment options, and retirees are also eligible to receive life annuity payments based on their DC account balance. At retirement, PERS automatically pays employees the *maximum* retirement benefits for which they are eligible. The fact that employees can expect to receive higher retirement benefits when equity market returns have been

[1] The quote comes from page 12 of "The Oregon Public Employees Retirement System History, The First 60 Years," published by PERS on July 6, 2010.

high makes the pension more generous to employees—and more expensive to employers—than if PERS only used the DB benefit formula. Similarly, the fact that employees are insured against downside market risk makes the pension more generous to employees—and more expensive to employers—than if PERS only used the DC benefit formula.

Our goal in this paper is to measure the impact of PERS's hybrid structure on employer costs and employee behavior. We begin by comparing the actual retirement benefits of PERS retirees to the hypothetical benefits they would have received if PERS were a traditional DB plan. We find that the incremental costs of the hybrid pension plan are economically significant. One way to measure these costs is as the expected present values of the retirement benefits owed to employees who retire during our sample period, 1990 to 2003. We find that retirement benefits are 57.3% higher under the hybrid pension plan than they would have been under the DB benefit formula in PERS, increasing employers' costs by $7 billion. Another way to measure the incremental employer costs is to calculate the replacement rate employers pay per year of service. Under its DB benefit formula, PERS pays employees 1.67% of their final average monthly salary per year of service. To match the actual benefit payments we observe, the average payout factor would need to be 2.54%, which is 51.3% higher. The hybrid plan also exposes employers to greater uncertainty about the level of the incremental costs. The average implied payout factor ranges from 2.09% in 1990 to 2.91% in 2000. Because PERS employers must pursue relatively safe investments to satisfy their obligations under the DB benefit formula, when equity market returns are high, returns in the employee's retirement accounts are likely to exceed those in the employer's retirement accounts, resulting in increased underfunding. Put differently, offering the DC benefit formula exposes PERS employers to market risk.

We find strong evidence that the hybrid pension plan distorts employee retirement behavior. The simplest way to demonstrate these distortions is to note that as average retirement benefits increase above the levels they would be in a traditional DB plan, average retirement ages fall. In part, this pattern reflects the fact the high market returns of the 1990s allow some retirees to earn more in retirement benefits than they earned in salary. To the extent that the hybrid pension allows employees to fund their retirement after fewer years of service, it will increase employee turnover rates, which will, in turn, increase administrative costs as employers must hire and train more employees.[2]

To provide more direct evidence on the link between pension design and employee behavior, we exploit two sources of variation in retirement incentives. The first arises from the use of the "last known rate" to calculate retirement benefits.[3] Consider an employee deciding whether to retire in December 1992. Because PERS has not yet "finalized" the annual returns earned in employee retirement accounts in 1992, it calculates retirement benefits under the assumption that the finalized return in 1992 will equal the finalized return in 1991. Since the finalized return in 1991 was 15% and the finalized return in 1992 was 8%, retiring in December 1992 allows the employee to increase her retirement benefits by 7%.[4] We find evidence that employees respond to this form of retirement incentive. This is true both in regressions predicting individual retirement decisions and in graphs showing how the number of retirements in January and February (when employees are best able to estimate the retirement incentive due to stale returns) falls sharply after PERS eliminates the use of stale returns in January 2000.

The second source of variation arises from a change that PERS made to its DC benefit formula. Effective July 2003, PERS updated the "actuarial equivalency factors" that are used to convert an employee's retirement account balance into an initial monthly retirement benefit. Because life expectancies had increased significantly in the decades since the factors were last updated, the new factors were lower than the old factors. This well-publicized change gave employees who expected to receive retirement benefits calculated using the DC benefit formula a strong incentive to retire before July 2003. As suggested by the large number of retirements that we observe in the first six months of 2003, we find strong evidence in our regressions that employees are willing to retire to prevent a reduction in their retirement

---

[2] Goda, Shoven, and Slavov (2009) discuss similar policy issues that arise from the retirement incentives built into the U.S. Social Security system.
[3] Although it is possible to design a hybrid pension plan that does not use stale returns, and PERS actually eliminates this feature in January 2000, Stanton (2000) argues the use of stale returns in corporate pensions was commonplace.
[4] This example assumes that 100% of her employee contributions are invested in the "regular" investment option. Because returns are more volatile in the "variable" investment option, the retirement incentives associated with the last known rate are highest, on average, among the subset of employees who invest 25% in the "regular" option an 75% in the variable option.

benefits. This finding is important because it implies that attempts to lower future pension obligations are likely to leave employers with significantly fewer employees, at least in the short-run.

Finally, because we possess data on employees who work for hundreds of different employers, we test for peer effects in the retirement decision. Our motivation is the idea that employees are likely to learn about retirement incentives related to stale returns or upcoming changes in benefits from their co-workers. We find strong evidence of peer effects across a variety of different specifications. Namely, employees respond more strongly to their own retirement incentives when more of their coworkers face the same retirement incentives. To the extent that peer effects amplify the reactions to retirement incentives, including those that might not have otherwise been salient to the typical retiree, they are likely to increase the administrative costs associated with hiring new employees.

Our paper is organized as follows. In Section 2, we compare and contrast the PERS hybrid pension plan with a traditional defined benefit retirement plan, with an emphasis on both how employers can adjust the generosity of these plans, and on the retirement incentives they create for employees. In Section 3, we describe our sample of retirement-eligible employees and retirees. In Section 4, we estimate the cost of the PERS hybrid pension plan to employers. In Section 5, we use individual-level data to study the impact of retirement incentives and employee characteristics on the retirement timing decision. We also describe our tests for peer effects. In Section 6, we describe the structural changes made to PERS between late 2003 and today, and we discuss the potential impact of these changes on employers and employees alike. In Section 7, we conclude.

2. Institutional Details

The Oregon Public Employees Retirement System uses benefit formulas drawn from both defined benefit (DB) and defined contribution (DC) pension plans. Before describing how retirement benefits are calculated in this hybrid pension plan, we describe how benefits are calculated in a traditional DB pension plan, which serves as a useful benchmark.

2.1. Calculating Retirement Benefits in a Traditional Defined Benefit Pension Plan

In a traditional defined benefit plan, the employee and employer both contribute into an account intended to cover the employee's future retirement benefits. In PERS, the employee's contribution rate is 6.0% of her salary, while the employer's contribution rate varies with the level of underfunding. Importantly, because the employee's retirement benefits are independent of the returns earned on the employee and employer contributions, the employee is fully insured against financial market risk. Instead, the DB retirement payment in month t is calculated as the product of five inputs:

$$\boldsymbol{DB_t} = \textit{Final Salary} \times \textit{Years of Service} \times (100\% - \textit{Early Retirement Factor}) \times \text{Payout Factor} \times \text{COLA}_t$$

Employees can impact (up to) three of these inputs.[5] The monthly payment is increasing in both the employee's monthly salary before retirement and the employee's number of years of service. For an employee who chooses to retire before the plan's stipulated "normal" retirement age, the monthly retirement benefit is decreasing in the number of years until the employee reaches the normal retirement age. Within PERS, *Final Salary* is typically the employee's average monthly salary over the past 36 months; *Years of Service* is the number of months that the employee contributed into PERS divided by 12; *Early Retirement Factor* reduces retirement benefits by 8% per year between the employee's current age and her normal retirement age. Plan sponsors, like PERS, can impact the expected generosity of the retirement benefits by changing the normal retirement age, payout factor, cost-of-living adjustment, or employee contribution rate. Between 1973 and 2003, PERS made all four types of changes. However, the two changes that reduced expected retirement benefits only applied to new employees.[6]

2.2. Retirement Incentives Embedded in a Traditional Defined Benefit Pension Plan

Stock and Wise (1990) demonstrate that a defined benefit retirement plan gives employees a strong incentive to work until they are eligible for normal retirement benefits, but a weak incentive to

[5] This formula applies to a single life annuity, which stops making retirement benefit payments when the retiree dies. We are abstracting from the choice between a single life annuity and a joint life annuity because this choice is available in both PERS and traditional defined benefit plans.

[6] This is because changes that reduce expected benefits are more likely to be met with lawsuits from employees than changes than increase expected benefits. For example, Colorado Senate Bill 10-001, passed in February 2010, reduced Colorado PERA's annual COLA from a fixed 3.5% to an amount capped at 2.0%. That change triggered a series of class action lawsuits.

continue working thereafter. Consider an employee who is eligible for early retirement benefits in month *t* (at age 55, with 27 years of service) and normal retirement benefits in month *t+36* (at age 58, with 30 years of service). To determine the impact of each additional year of employment on the employee's retirement benefits, we can compare the initial retirement benefits in years *t, t+12, t+24, t+36,* and *t+48*. We state the initial monthly retirement benefit as a replacement rate, which measures the monthly benefit as a fraction of the employee's final average monthly salary.

$$\begin{aligned}
\textbf{\textit{Replacement Rate}}_{t} &= 27 \times (100\% - 24\%) \times (1.67\%) = 34.27\% \\
\textbf{\textit{Replacement Rate}}_{t+12} &= 28 \times (100\% - 16\%) \times (1.67\%) = 39.28\% \\
\textbf{\textit{Replacement Rate}}_{t+24} &= 29 \times (100\% - 8\%) \times (1.67\%) = 44.56\% \\
\textbf{\textit{Replacement Rate}}_{t+36} &= 30 \times (100\%) \times (1.67\%) = 50.10\% \\
\textbf{\textit{Replacement Rate}}_{t+48} &= 31 \times (100\%) \times (1.67\%) = 51.77\%
\end{aligned}$$

The replacement rate jumps from 0% to 34.27% in month *t*, when the employee becomes eligible to receive retirement benefits, and then rises rapidly as the employee moves from early retirement to normal retirement. However, once the employee is eligible for normal retirement benefits, the replacement rate only increases by the payout factor, which can be a smaller increase than implied by the cost-of-living adjustment in retirement. Since one more year of work is one less year of retirement benefits, the general prediction is that employees will retire at the normal retirement age.[7] Therefore, within a traditional defined benefit pension plan, retirement dates should be relatively easy to predict based on employee ages and years of service. One caveat is that, if an employee's pension benefits offer insufficient consumption in retirement, the relevant retirement age may come from the Social Security Administration.

There are two reasons that we might observe retirement waves within a traditional DB pension plan. The first would be if employees were hired in waves. Because these retirement waves should be easily anticipated, the costs associated with employee turnover can be reduced relative to turnover that is less easily anticipated. The second is that employees are given a strong (and salient) retirement incentive. For example, attempts to reduce the benefits of existing employees who retire after a specified future date are likely to trigger retirements before that date, just as they would be in other types of pension plans.

[7] Employees who no longer work at the firm have an even stronger incentive to claim their retirement benefits at the normal retirement age, because they lack the ability to increase their final average salary by working another year.

2.3. Calculating Retirement Benefits in PERS Hybrid Pension Plan

PERS combines elements of defined benefit and defined contribution pension plans. For employees who contributed into PERS before August 21, 1981, monthly retirement benefits, when taken as a life annuity, are the maximum of those implied by three benefit formulas:

$$(1)\quad \boldsymbol{DB} = \textit{Final Salary} \times \textit{Years of Service} \times \textit{Early Retirement Factor} \times 1.67\%,$$

$$(2)\quad \boldsymbol{DC} = \textit{PERS Account Balance} \times \textit{Actuarial Equivalency Factor} \times 2,$$

$$\begin{aligned}(3)\quad \boldsymbol{DCDB} &= \textit{Final Salary} \times \textit{Years of Service} \times \textit{Early Retirement Factor} \times 1.00\% \\ &\quad + \textit{PERS Account Balance} \times \textit{Actuarial Equivalency Factor} \times 1 \\ &= 0.600 \times \boldsymbol{DB} + 0.500 \times \boldsymbol{DC};\end{aligned}$$

where *Final Salary* is typically the employee's average monthly salary over the past 36 months; *Years of Service* is the number of months that the employee contributed into PERS divided by 12; *Early Retirement Factor* reduces retirement benefits by 8% per year between the employee's age and her normal retirement age; *PERS Account Balance* is the employee's account balance within the PERS defined contribution plan; and *Actuarial Equivalency Factor* is an age-based, gender-neutral annuity factor that is set by PERS actuaries.[8] The early retirement age is 50. The normal retirement age is 58 (or 30 years of service) for "Tier 1" employees hired before January 1, 1996, and 60 (or 30 years of service) for "Tier 2" employees hired between January 1, 1996 and August 28, 2003. (None of the employees hired after August 28, 2003 are eligible to retire before our sample ends in December 2003. We discuss their pension benefits in Section 6.)[9] The *PERS Account Balance* depends on how employee contributions are allocated across the "regular" and "variable" investment options, and the returns earned on those investments each year. Tier 1 employees are guaranteed a minimum annual return of 8% in the regular option whereas Tier 2 employees receive the market return.

For employees who first contributed into PERS after August 21, 1981, monthly retirement benefits are the maximum of those calculated under the *DB* and *DC* benefit formulas. Therefore, while eliminating the DCDB formula reduces the expected generosity of the PERS retirement benefits (because there

[8] The formulas that we report are for "normal" employees, who are not police or fire officers. The payout factors in the *DB* and *DCDB* benefit formulas are higher for police and fire officers (2.00% and 1.35% versus 1.65% and 1.00%).

[9] The normal retirement age for police and fire officers is 55, which drops to 50 with 25 years of service.

are parameter values under which these newer employees would have earned higher benefits under DCDB), it does not change the fact that PERS offers employees the option to receive benefits based on salary and years of service or their retirement account balance.[10] It is this flexibility that increases the expected generosity of the PERS pension plan relative to a traditional DB pension plan based on formula (1). To see this, note that any actual retirement benefit can be mapped back into the DB benefit formula by changing the payout factor,

$$(4)\quad \textbf{\textit{Actual}} = \textit{Final Salary} \times \textit{Years of Service} \times \textit{Early Retirement Factor} \times \textit{Implied Payout Factor}$$

Because ***Actual*** is greater than or equal to ***DB*** by construction, the *Implied Payout Factor* is greater than or equal to the payout factor used in equation (1). The larger the *Implied Payout Factor* we calculate for retiree *i*, the more generous her retirement benefit. Of course, because different retirees receive payments calculated using different benefit formulas, the *Implied Payout Factor* will vary across retirees in a way that it would not in a traditional DB pension plan.

2.4. Retirement Incentives Embedded in PERS Hybrid Pension Plan

When an employee expects to retire under the ***DB*** benefit formula, her retirement incentives are tied to her age and years of service. We expect her to work until she is eligible to receive normal retirement benefits and retire soon thereafter. In contrast, when an employee expects to retire under the ***DC*** benefit formula, she has no such retirement incentives. As Stock and Wise (1990) demonstrate, a traditional defined contribution plan reduces the impact of employee age and years of service on retirement timing decisions, because it reduces the "option value" of work. For example, because there are no explicit early retirement penalties built in the ***DC*** benefit formula, the decision to retire at age 57 or 58 depends only on how much the employee expects her retirement account balance to grow over that 12 month period. In other words, to the extent that we expect to observe retirement waves in a traditional DC pension plan, we expect them to be driven by shared equity market returns rather than by shared ages or years of service.

---

[10] In their study of retirement payout choices, Chalmers and Reuter (2012) find that 10.1% of the PERS retirees in their sample receive lower retirement benefits because they are ineligible for ***DCDB.***

We observe two sources of exogenous variation in PERS retirement benefits. The first is the use of stale returns when calculating the account balances used to determine *DC* benefits. The second is administrative changes to the actuarial equivalency factors use to calculate *DC* benefits. In Figures 1a and 1b, we provide a timeline of when we observe each source of variation, and a summary of how it impacts employee retirement incentives under the ***DC*** (and ***DCDB***) benefit calculation. Because both sources of variation impact a large number of PERS employees, they have the potential to trigger a large number of retirements.

2.4.1. Stale Returns

Our first source of variation in retirement incentives comes from how PERS calculates retirement account balances within its defined contribution plan, and is also strongest for those retiring under the *DC* retirement benefit calculation. Every April, PERS provides employees with a statement that reports the retirement contributions and investment returns credited to the employee over the prior calendar year, and the current account balance. Prior to January 1, 2000, the timing of this report reflected the fact that PERS did not finalize annual returns for the regular and variable accounts in year *y* until the end of February in year *y+1*. Moreover, PERS did not utilize estimated year-to-date returns. Consequently, the PERS Account Balances of employees retiring prior to January 1, 2000 were based, at least in part, on stale returns.[11] Consider a member who retires in February 1998, before PERS finalizes the annual returns for 1997 and 1998. His retirement account balance for 1997 and the first two months of 1998 will be credited with the "finalized" 1996 return of 21.0% despite the fact that the 1997 returns were 18.7% (finalized on March 1, 1998) and the 1998 returns were 14.1% (finalized on March 1, 1999). In this example, the member benefits from the use of stale returns. Moreover, to the extent that employees understood how PERS calculated account balances, the incentive to retire in February 1998 (rather than March 1998) was apparent at the time because employees could easily observe market returns in 1997 and the first part of 1998. Effective January 1, 2000, PERS began calculating account returns each month, thereby eliminating retirement incentives due to stale returns. We summarize these retirement incentives

[11] Stanton (2000) studies the option value of exploiting stale returns within 401(k) plans.

in Figure 2a, which plots the average, minimum, and maximum fluctuations in retirement benefits due to stale returns over our sample period.

2.4.2. Changes to Actuarial Equivalency Factors

Our second source of variation in retirement incentives comes from changes to Actuarial Equivalency Factors, which convert the PERS retirement account balance into a monthly life annuity payment under the *DC* (and *DCDB*) retirement benefit calculation. On January 1, 1997, the Actuarial Equivalency Factor table was changed from being updated once a year, in the employee's birth month, to being updated monthly. Under the earlier, annual tables, monthly retirement benefits under ***DC*** could be as much as 4.10% lower if the employee retired in the month immediately before her birth month (1.75% lower at the median). In other words, between January 1990 and December 1996, employees who expect to receive the ***DC*** (and ***DCDB***) retirement benefit have an incentive to postpone retirement in the months leading up to their birth month.

The larger and more salient source of variation comes from the fact that, effective July 1, 2003, the Actuarial Equivalency Factors were reduced between 1.4% and 17.8% (with large decreases for older retirees) to bring them into line with then-current national mortality tables. For employees between 58 and 65, the Actuarial Equivalency Factors decreased by 5.8% to 10.2%. These changes, which were well publicized, created strong incentives for employees retiring under *DC* (and, to a lesser extent, *DCDB*) to retire before July 1, 2003. For the median employee eligible to retire under DC, monthly life annuity payments are 5.3% higher if she retires in June 2003 instead of July 2003. The incentive to retire in June 2003 ranges from 2.7% to 21.1%, with stronger incentives for older employees.

In Figure 2b, we plot the average change in retirement benefits that an employee would receive if she retired now rather than waiting for the next known change to her Actuarial Equivalency Factor. We also plot the range of possible changes. In each case, the change in retirement benefits is measured as a monthly return, from the date of the possible retirement to the date of the change. Between January 1990 and December 1996, the next known change occurs in the employee's birth month or in January 1997, whichever comes first. The negative returns during this period measure the cost to employees retiring in the months leading up to her birth month under ***DC***. In contrast, the large positive returns leading up to June 2003, measure the growing incentive for employees retiring under ***DC*** to retire before the change in the Actuarial Equivalency Factors tables on July 1, 2003.

3. Data

In 2006, PERS held nearly $56 billion in assets, making it the 22nd largest public or private pension fund in the country. PERS covers approximately 95% of all non-federal public employees in Oregon. Participating employers include all state agencies, universities, and school districts; and almost all cities, counties, and other local government units. Administrative data obtained from PERS allow us to calculate employee *i*'s retirement benefits under the DB, DCDB, and DC benefit formulas if she chooses to retire in month *t*. These data also allow us to determine when employee i becomes eligible to receive PERS retirement benefits and, when employee i is currently employed, the PERS employer code. Note that PERS chose to exclude legislators and judges from our data, and we chose to exclude employees of the Oregon University System because, unlike other state and local employees, they are given the choice between PERS and a portable defined contribution retirement plan.[12]

Our main sample includes 62,953 unique employees who are either eligible to retire on January 1990 or become eligible to retire between January 1990 and December 2003.[13] Because we are interested in testing whether employees learn about their retirement incentives from co-workers, we exclude former employees. Panel A of Table 1 provides annual summary statistics for all retirement-eligible employees. The average nominal monthly final average salary ranges from $2,319 in 1990 to $3,667 in 2003. The average replacement rate, calculated as the monthly benefit that the employee would receive upon retirement divided by the employee's salary over the prior 12 months, increases from 27% in 1990 to 39% in 1998, and then decreases to 33% in 2003. Among retirement-eligible employees, the fraction of female

[12] In addition, the fact that PERS employer codes do not distinguish between the seven universities prevents us from testing whether an employee's retirement decisions is influenced by the retirement decisions of her peers.
[13] The administrative data that we use to estimate employee retirement benefits come from the computer system that PERS used between 1990 and 2003. Data after 2003 are unavailable because PERS changed computer systems again in 2004, when it introduced a new retirement plan for new employees.

employees increases from 54.7% in 1990 to 60.5% in 2003; the fraction working as police and fire fighters ranges from 5.7% to 8.1%. A useful benchmark not reported in Table 1, is that the unconditional probability of retirement in any given month among the individuals represented in Panel A is 1.46%.

Panel B provides annual summary statistics for the 35,128 employees who choose to begin collecting their retirement benefits between January 1990 and December 2003. Comparing Panels A and B, we see that retirees have monthly salaries that are 17-26% higher, replacement rates than are 24-68% higher, and three to seven more years of service than their non-retiring peers. Interestingly, the average retirement age falls from 60.6 years at retirement in 1990 to 58.5 years old in 2003. The time-series correlation between the average replacement rate and the average retirement age is -0.95, suggesting that higher retirement benefits allow for earlier retirements.

We graph the fraction of retirement eligible employees who retire each month in Figure 3. Retirements by teachers at the end of the school year help to explain the retirement spikes in June. However, the spikes at the beginning and end of 1999 are likely due to the last known rate, and the spikes in the first six months of 2003 are likely due to the reduction in actuarial equivalency factors that took effect on July 1, 2003.

We also study a second sample of retirees, which is slightly larger because it does not condition on being employed in the months prior to retirement. Because the summary statistics for this sample of 41,940 retirees are similar to those in Panel B, we do not report them. However, the larger sample is helpful for measuring the total cost of the hybrid pension plan to employers, which is our goal in the next section.

4. Estimating the Incremental Costs of the Hybrid Pension Plan to Employers

PERS guarantees that employees will receive retirement benefits no lower than those offered by a traditional defined benefit pension plan, but also provides them with the option to receive higher retirement benefits based on the equity market returns earned over their careers. In Table 4, we estimate the *ex post* value of this embedded option. To do so, we benchmark retiree's actual benefits against the benefits that they would have received under the *DB* benefit formula. To be clear, we are benchmarking the pension plan that employees were offered at the time of employment against a less generous alternative. Our goal is not to pass judgment on the size of the additional benefit payments, but rather to measure the *ex post* benefit to employees and associated *ex post* cost to employers arising from the embedded option.[14] Any discussion of efficiency must focus on distortions in the behavior of employees and employers resulting from this option, rather than on the promised "transfer" from employers to employees.

Between 1990 and 2003, in our larger sample, we observe retirements by 41,940 employees. While 5,188 (12.4%) receive their actual retirement benefits under the *DB* benefit formula, the other 36,572 (87.6%) receive additional benefits due to the availability of the *DCDB* and *DC* benefit formulas. We measure these additional benefits in three ways, in each case assuming that retirement dates are exogenous, and that employees choose to receive all of their retirement benefits as life annuity payments.[15] First, we focus on replacement rates. We find that employee's actual replacement rates are 18.3 percentage points higher, on average, than they would have been under a traditional DB plan (52.1% versus 33.8%). Under this measure, benefits are 54.1% higher because of the embedded option. Second, we focus on the payout factor, which is the replacement rate that employers pay per year of service. Under the DB formula, PERS pays employees 1.67% of their final average monthly salary per year of service. To match the actual benefit payments that we observe, the average payout factor would need to be 2.54%, which is 51.3% higher. Finally, following Novy-Marx and Rauh (2011), we focus on the expected present value of the retirement benefits owed to new retirees.[16] For our subset of PERS retirees, we estimate that pension obligations are 57.3% higher under the hybrid pension plan than they would have been under the DB benefit formula in PERS, increasing employers' costs by approximately $7 billion (measured in

[14] Note that we are measuring the net impact of the particular way that the PERS pension plan combines elements from DB and DC plans, including the net impact of the changes they made during our sample period. Our specific estimates are unlikely to generalize to other pension plans.

[15] Chalmers and Reuter (2012) show that within this sample 85% of retires choose to receive all of their benefits in the form of a life annuity.

[16] For this calculation, we use retiree i's gender and age at retirement and life tables from the Social Security Administration for 2004 to determine the probability that she receives each future monthly payment, we assume an constant annual cost of living adjustment of 2.00%, and we use the prevailing yield on 10-year U.S. Treasury notes as our discount rate.

constant 2003 dollars). By way of comparison, PERS estimates the difference between pension liabilities and pension assets is approximately $17 billion in 2003 and $15 billion in 2009, and Novy-Marx and Rauh (2001) estimate the difference to be approximately $38 billion in 2009. Therefore, while we likely would have observed underfunding even if benefits were capped at defined benefit levels, the estimated impact of the embedded option on the level of PERS underfunding is economically significant.

Providing retirees with the maximum retirement benefits for which they are eligible also increases dispersion in realized retirement benefits (holding inputs like salary and years of service constant). The average implied payout factor ranges from 2.09% in 1990 to 2.91% in 2000. This dispersion is likely to increase uncertainty about the ultimate cost of providing retirement benefits to new and existing employees. And, because PERS employers must pursue relatively safe investments to satisfy their obligations under the DB benefit formula, when equity market returns are high, returns in the employee's retirement accounts are likely to exceed those in the employer's retirement accounts, resulting in increased underfunding. Thus, employers face considerable market risk because of PERS hybrid features.

5. Analysis of Employees' Retirement Timing Decisions

Our analysis of the employee retirement timing decision proceeds in five steps. First, motivated by the predictions in Stock and Wise (1990), we present evidence on the retirement ages of employees receiving retirement benefits under the three different benefit formulas. Second, we estimate a baseline model to predict the year and month in which an individual will choose to retire. We use individual-specific information such as age, gender, job type, projected retirement benefit, and *ex post* mortality measures, as well as exogenous variation in retirement incentives described in the prior section. The baseline model allows us to test whether employees respond to the different retirement incentives generated by the hybrid structure, and to quantify the effects.

Next, to test for peer effects in the retirement decision, we add the actual retirement decisions of an individual's coworkers to the baseline model. To help distinguish peer effects from alternative explanations such as unobserved heterogeneity among employers, we include controls that vary at the employer-date level, such as the fraction of non-retirement eligible employees leaving the employer in month *t*. In addition, we instrument coworker retirements with several sources of exogenous variation in coworker retirement incentives. Third, to test whether peer effects reflect the diffusion of information about retirement incentives, we test whether employees are disproportionately more likely to respond to retirement incentives when more of their coworkers face the same incentives. Finally, to shed light on whether the peer-induced retirements that we observe are harmful, we estimate reduced-form regressions for different samples of retirement-eligible employees.

5.1. Retirement Ages and Retirement Benefit Formulas

In Table 3, we report the distribution of the retirement ages for employees who receive benefits under the *DB, DCDB*, and *DC* formulas. We begin with the sample of retirees described in Table 1 Panel B. However, to facilitate comparisons across benefit types, we exclude 3,017 retirees who were first hired on or after January 1, 1996, or who were police or fire officers. This leaves us with a sample of retirees for whom the early retirement age is 55 and the normal retirement age is 58 (unless the employee has 30 years of service before age 58).

We find strong support for Stock and Wise's (1990) prediction that employees receiving DB-style benefits will be more likely to work until the normal retirement age than employees receiving DC-style benefits. Retirees receiving *DB* and *DCDB* benefits are four to five times more likely to retire at age 58 than they are at age 55. In contrast, retirees receiving *DC* benefits are more likely to retire at age 55, when many of them first become eligible to collect retirement benefits, than at age 58. By age 58, we have observed 54.7% of the retirements under *DC* versus only 31.8% under *DB*. Another interesting pattern in Table 3 is the relatively large fraction of employees who retire at age 62, especially under the *DB* benefit. The implication is that the *DB* benefit, which is (relatively) less generous, on average, requires some employees to delay retirement until they are also eligible to collect Social Security benefits. Overall, the patterns in Table 3 suggest that the hybrid pension plan, by driving up expected retirement benefits, drives up early retirements.

5.2. Baseline Retirement Timing Model

In Table 4, we use linear probability models to explain the retirement timing decisions of retirement-eligible employees. Because PERS retirement incentives can vary significantly from coworker to coworker and from month to month, the dependent variable equals one if employee *i* retires from employer *j* in month *t*, and zero otherwise. (In contrast, virtually all existing studies focus on predicting the year (or age) of retirement.) In column (1), we focus on the full sample of retirement-eligible employees. In columns (2) through (5), we restrict the sample to female employees, active police and fire officers, employees who are 62 or older (and, therefore, at least eligible for early entitlement Social Security benefits), and employees whose birth month is month *t*. Coefficient estimates are multiplied by 100, so that 100 represents 1 percentage point. To allow for correlated behavior within employers, standard errors are clustered on employer.

In addition to the employee characteristics and retirement incentives variables described below, we include fixed effects for each of the 34 ages (measured in years) between 46 and 79.[17] We also include a separate fixed effect for each of the 168 months in our sample period (January 1990 through December 2003). However, because our sample combines school districts that operate on a nine-month schedule with employers that operate on a year-round schedule, we interact each date fixed effect with a dummy variable that indicates whether employer *j* operates on a nine-month schedule. These date-by-employer-type fixed effects allow us to control for the fact that school district employees are more likely to retire in June. More generally, by including date-by-employer-type fixed effects, we "remove" the average retirement effects due to PERS plan changes and any other time-specific event within our sample period. In other words, we use within-period, within-employer-type, within-age variation to estimate the coefficients in Table 4.

Because we predict that employee *i* will be more likely to retire when her expected retirement benefits are more generous, we include two measures of generosity. The first is the fraction of employee

[17] Although we limit our sample to ages between 46 and 79, doing so throws out few observations. We only have 4 observations before age 46 and 554 observations after age 79.

i's current monthly income that she would receive each month from PERS in retirement.[18] Consistent with our prediction, the coefficient on the replacement rate is positive and statistically significant at the 1-percent level. The estimated coefficient of 3.451 implies that a one-standard deviation increase in the replacement rate (0.245) increases the probability of retirement by 0.85 percentage points. This effect is economically large; the unconditional probability of retiring in a given month is only 1.46%.

Our second measure of generosity is a forward-looking measure that estimates the utility gain from deferring retirement until the optimal retirement time. The "option value of retirement" was introduced into the literature by Stock and Wise (1990), who presented both theoretical and empirical evidence that a worker's propensity to retire is negatively related to the gains from delayed retirement—the more a worker gains from delaying retirement the less likely he is to retire today. We implement the Stock and Wise (1990) model by calculating the present value of a member's dollar wealth when retiring on the optimal date (including both labor and pension income) and subtracting the present value of a member's dollar wealth when retiring today.[19] When the optimal retirement is today, the difference between these numbers is zero. When the optimal retirement date is in the future, the difference between these numbers is strictly positive, and it measures the present value of the benefit of deferring retirement.[20] The measure that we include in our regressions is divided by employee i's average annual salary over the past 12 months. The predicted sign is negative. The coefficient on the scaled option value of retirement measure is negative in three of the five specifications, but only statistically significant from zero in the sample of employees age 62 or older. However, it does not appear to be economically significant. Even the esti-

---

[18] This is defined as the expected monthly retirement income that employee i would receive if she retired in month *t* scaled by her average monthly salary over the past 12 months

[19] Variations of the Stock and Wise measure have been used by Samwick (1998), Chan and Stevens (2004), Chan and Stevens (2008), Coile and Gruber (2007), and others.

[20] Our estimation requires several assumptions. We assume that annual wage growth is 2% and that the annual discount rate is 3%. PERS makes COLA adjustments to the benefit each August that is set at the smaller of Portland's CPI and 2%. Since Portland's CPI was rarely under 2%, we assume the annual adjustments would always be 2%. Consistent with prior research, we assume that members are risk averse and that members value retirement income more than labor income (i.e., members would rather not work). We pick the same parameter values as Samwick (1998). Specifically, we set gamma=0.75 for risk aversion and k=1.5 for the preference for retiring. When k=1.5, members are indifferent between working to earn $3 and retiring to collect $2. Last, we forced members to retire by age 80 because PERS does not calculate the *Actuarial Equivalency Factors* beyond age 80. Given the very small number of members who actually choose to retire beyond age 80, this last assumption does not seem unreasonable.

mated coefficient of -0.021 in column (4) implies that a one-standard deviation increase (7.793) only decreases the probability of retirement by 0.16 percentage points.

Of more interest to us are four variables that isolate the short-run retirement incentives (or disincentives) generated by the use of stale returns in the PERS account balance calculation (*DC_delta*) and by changes in annuity factors *(AEF_delta)*. Each variable measures the change in retirement benefits (as a monthly return) from retiring in month *t* relative to waiting for the updated annual returns or annuity factors to take effect. Therefore, the predicted sign on each variable is positive.

Our stale return variable takes on non-zero values between January 1990 and December 1999 (see Figure 2a). We interact it with two dummy variables, one indicating whether month *t* is January or February and another indicating whether it is March through December. This is because the incentives (or disincentives) of having retirement benefits calculated using stale returns should be clearest in January or February, after the prior year's equity market returns have been fully realized. *DC_delta* has a mean of -0.14% and standard deviation of 2.5% in the years between 1990 and 1999, but ranges between -32.2% and 30.9%. The coefficient on the variable measuring retirement incentives in January and February is statistically significant at the 1-percent level, but of modest economic significance. A one standard deviation increase is associated with a 0.29 percentage point increase the probability of retirement.

We include two AEF variables, capturing changes in two different time periods (see Figure 2b). Between January 1990 and December 1996, AEFs are updated annually, in the employee's birth month. Over this period, employees who retire in the month immediately before their birth month receive benefits that are as much as 4.3% lower. In July 2003, PERS introduced updated AEF tables. In the first six months of 2003, *AEF_delta* has a mean of 1.4% and standard deviation of 2.0%, but ranges between 0.0% and 21.1%. The coefficient on this variable is both statistically significant at the 1-percent level and economically significant. Here, a one standard deviation increase is associated with a 1.73 percentage point increase the probability of retirement. Note that since a 1-percentage point increase in *DC_delta* and *AEF_delta* has the same expected impact on retirement benefits, the fact that coefficients differ across our two main variables implies that the retirement incentives due to stale returns were much less well-known than the retirement incentives due to the changing actuarial equivalency factors.

To study whether employee retirement decisions are constrained by retirement eligibility rules, we introduce dummy variables to indicate whether employee i became eligible for early retirement benefits in month *t*, in months *t-1* through *t-11*, or prior to month *t-11*, and to indicate whether employee i became eligible for normal retirement benefits in months *t* or in months *t-1* through *t-11*. (The omitted category is being eligible for normal retirement for twelve or more months.) Similarly, to control for the possibility that members are more likely to retire in their birth month, we introduce a dummy variable that indicates whether month t is employee i's birth month. (This variation drops out of the regression in column (5), when we restrict the sample to each employee's birth month.) We find that individuals are much more likely to retire in a birth month (0.998 percentage points) and in the first month that they are eligible for normal PERS retirement benefits (3.021 percentage points).

As *ex post* measures of health, we introduce a dummy variable that indicates whether the member dies over the next 12 months and another that indicates whether he dies over the next 48 months. Since we possess information on employee deaths through the end of 2007, we are able to define these dummy variables for every retirement-eligible employee in every year of our sample. To the extent that these future deaths are good proxies for relatively poor health today, the predicted signs on both coefficients are positive. Consistent with this prediction, both *ex post* mortality measures are economically significant predictors of retirement. An individual who dies within the next 12 months is 1.029 percentage points more likely to retire today.[21]

Other continuous variables include years of service, which is positively correlated with the retirement decision, and the unemployment rate within the county in month *t*, which is negatively correlated with the retirement decision in some specifications. For completeness, we also include dummy variables indicating whether employee i is female, actively employed as a police or fire officer, eligible for Tier 2 pension benefits, or would receive benefits calculated under *DC, DB*, or *DCDB* (the omitted category).

[21] Equal to the sum of 0.819 and 0.210, since the variable "dies within 48 months" excludes the subset of employees that die within twelve months.

When we restrict our sample to the subset of members who are female (column (2)) or active police and fire (column (3)), the estimated coefficients on the variables of interest are qualitatively similar to those found in the earlier specifications. The one interesting difference is that police and fire are even more likely to retire in the first month in which they are eligible for normal PERS retirement benefits (10.243 percentage points versus an unconditional probability of 1.25 percent).

5.3. Testing for Peer Effects

PERS employees may have many peers, each important in a different context. Because we are interested in testing whether employees learn about their retirement incentives from co-workers, we define peers as those people who work for the same employer and are eligible for retirement in the same month.[22] In many cases, this gives relatively fine peer groups. For example, employers include individual school districts (e.g., Jackson County School District #1 and Jackson County School District #10), city employers (e.g., City of Madras and City of Klamath Falls), and fire districts (e.g., Rainier Fire Department and Keizer Fire Department). Many of our employers are quite small and have only a few employees (e.g., the Oregon Hazelnut Commission) while a few are quite large and have thousands of employees (the largest is the Portland School District). In our empirical work, we exclude employers in months where the employer has fewer than two retirement-eligible employees because peer effects are not defined when the PERS member has no retirement-eligible coworkers.

In Table 5, we extend our empirical specification to test for peer effects. With the notable exception of Brown and Laschever (2011), the existing literature does not allow for peer effects. Our measure of peer retirements, *frac_retire*, is the fraction of a member's retirement-eligible coworkers (excluding herself) that retire from employer j in month t. Our test for peer effects is whether the probability that employee i retires in month t is increasing in *frac_retire*. The decision to focus on retirements in month t

[22] If peer effects are driven by social norms, then various social peer groups might be important. This is the idea underlying the analysis in Hong, Kubik, and Stein (2004) which uses survey evidence on whether households interact with their neighbors or attend church to measure peer interaction. On the other hand, if either peer effects are driven by word-of-mouth communications or the information needed to make the retirement decision is employer-related, then employer-based peers are arguably the most important peer group since it is precisely those peers who are informed about the details of PERS.

(instead of in year *y* or at age *a*) is driven by the within-year, time-varying retirement incentives in the PERS system.

In column (1), we add *frac_retire* to an extended version of the specification in column (1) of Table 4. The estimated coefficient is 27.024, which is both statistically significant at the one-percent level and economically significant. Interpreted as a peer effect, a one-standard deviation increase in the fraction of peers retiring (3.36 percent) increases the probability of retirement by 0.91 percentage points, which is large given that the unconditional probability of retirement in month t is 1.46 percent. Therefore, within our sample, there is a strong correlation between individual retirement decisions and average retirements within the same employer and month, even controlling for individual-level predictors of retirements, age fixed effects, and date-by-employer type fixed effects. In fact, the estimated coefficients on the other variables—including employee i's short-run retirement incentives based on stale returns and changing actuarial equivalency factors—are almost identical to those estimated in Table 4, suggesting that *frac_retire* is essentially uncorrelated with our set of individual-level determinants.

5.3.1. Controls for Correlated and Exogenous Effects

A key question is whether the error term in column (1) is correlated with the peer effects variable due to unobserved employee characteristics or employer shocks. If so, the positive coefficient on *frac_retire* cannot be interpreted as a peer effect. Since *frac_retire* varies at the employer-date level, to help rule out correlated and exogenous effects, column (1) also includes three control variables that vary at the employer-date level.

First, to control for time-series variation in the quality of the employee's workplace (for example, whether the new boss is overbearing), we include turnover of non-retirement eligible employees within the same employer and month. Second, we control for the retirement behavior of PERS members who work for other employers located in the same county. We conjecture that these individuals might retire together because of common economic factors in their county, or because they are responding to common information in the local media outlets. Third, under the assumption that the former employees of employer *j* are a good control group for the current employees of employer *j*, we control for the fraction of former employees that retire in month *t*. The fact that the estimated coefficient on *frac_retire* is positive and statistically significant with these controls in the regression increases our confidence that we are identifying peer effects.

5.3.2. Instrumental Variables

To provide further evidence that we are identifying a peer effect, in the remaining columns of Table 5, we switch from OLS to instrumental variables. Our goal is to isolate variation in the fraction of coworker retirements that is being driven by exogenous variation in coworker's retirement incentives—rather than variation due to selection, firm-specific shocks or other unobserved commonality in individual characteristics—and ask whether this variation helps to predict the retirement of employee *i* in month *t*. In each column between (2) and (5), we estimate a different instrumental variables regression using a different instrument. Each instrument is calculated using all retirement-eligible employees who work at employer *j* in month *t*, excluding employee i. In column (6), we use estimate a single regression using all four instruments.

The first instrument is the average retirement incentive due to stale pricing in January or February; the second instrument is the average retirement incentive in the 12 months leading up to the change in actuarial equivalency factors in July 2003; and the third instrument is the average retirement incentive due to changing actuarial equivalency factors in the employee's birth month, which we can calculate between January 1990 and December 1996. The larger each of these instruments, the stronger the short-term retirement incentives faced by an individual's retirement-eligible coworkers. When employee *i* is eligible for the *DC* or *DCDB* retirement benefit calculations, the first and second instruments will be positively correlated with employee *i*'s own retirement incentives, which we control for directly in the regression. In contrast, the third instrument captures variation in coworker retirement incentives driven by the distribution of coworker birth months over the calendar year, which should be uncorrelated with employee *i*'s own retirement incentives. In other words, whereas the first and second instruments correspond to situations in which coworker retirements are informative about general retirement incentives, the third instrument is not.

When we use coworkers' average retirement incentives due to stale returns in January and February as our instrument in column (2), the estimated coefficient increases to 36.445, and remains statistically significant at the 1-percent level despite a 5-fold increase in its standard error. In contrast, when we use coworkers' average retirement incentives due to changes in the actuarial equivalency factors in 2003 as our instrument in column (3), the estimated coefficient falls to 15.364 and loses statistical significance (with a *p*-value of 0.243). One possible explanation for the different results in columns (2) and (3) is a difference in saliency. Whereas PERS repeatedly told employees about changes to the actuarial equivalency factors in July 2003, allowing employees to determine their own retirement incentives, PERS did not tell employees about the impact of stale returns on their retirement benefit calculations, forcing coworkers to learn about stale returns from coworkers. Of course, this explanation presupposes that peer effects are about the diffusion of information on retirement incentives, rather than the increased disutility of labor that comes from having friends retire.

When we use coworker retirement incentives based on the number of months to their birthday as our instrument in column (4), the estimated coefficient is large and negative, although the standard error is even larger. This is further evidence that peer effects are about the diffusion of information about retirement incentives that generalize to other coworkers. In column (5), we use the fraction of employee i's coworkers that have a birthday in month t as our instrument to explain variation in the fraction of employee *i*'s coworkers who retire in month *t*. Our original thinking was that employees who retire in their birth month will be less sensitive to retirement incentives, and that this instrument will allow us to measure peer effects driven by non-financial retirements. However, we found in Table 4 that employees retiring in their birth month are at least as sensitive to expected retirement benefits, local labor market conditions, and their own short-run retirement incentives as other employees. Therefore, the estimated coefficient of 22.659 in column (5) may also reflect the diffusion of information driven by time-series variation in the fraction of recently-informed coworkers.

In column (5), when we use all four instruments at the same time, the estimated coefficient on *frac_retire* is 20.454 and statistically significant at the 1-percent level. According to this estimate, a one standard deviation increase in *frac_retire* increases the probability that employee i retires in month t by 0.69 percent, which is slightly less than half of the unconditional probability of 1.46 percent. The evidence in Table 5 suggests both that we are identifying true peer effects, and that these peer effects reflect the diffusion of information about retirement incentives, rather than the increased disutility of labor associated with the retirement of friends.

5.3.3. Do Peer Effects Reflect Shared Retirement Incentives?

To test more directly whether peer effects reflect the diffusion of information about retirement incentives, we adopt the identification strategy of Bertrand, Luttmer, and Mullainathan (2000).[23] Because PERS retirement benefits are calculated using three different benefit formulas (*DB, DCDB,* and *DC*), different coworkers can face different retirement incentives within the same month. For example, while employees facing the *DC* benefit formula can time their retirement to exploit stale returns within the PERS retirement account, employees facing the *DB* benefit formula cannot. We use this fact to test whether individuals are *disproportionately* more likely to respond to their own retirement incentive when more of their coworkers face the same incentive.

In Table 6, we replace the fraction of employee *i*'s coworkers retiring in month *t* with variables that measure the quantity and expected behavior of coworkers facing the same retirement benefit calculation as employee *i*. First, for each employee, we calculate the fraction of her retirement-eligible coworkers who face the same retirement benefit calculation that she does in month *t*. The larger this fraction, the larger the number of peers with whom employee *i* can discuss her own retirement incentives. Second, within the full sample of employers, we calculate the fraction of retirement-eligible coworkers facing each retirement benefit that retire in month *t*. This variable measures the strength of the retirement incentives that employees facing each of the three retirement benefits has in month *t*. For example, by controlling for the fraction of employees who retire under the *DC* retirement in January 1998, we capture the

[23] Bertrand, Luttmer, and Mullainathan (2000) study the decision by individuals to participate in welfare programs. To test for peer effects, they interact the quantity of people who live in the same area and speak the same language as employee i with the average welfare participation rate for people who speak that language in the full cross section. They find that the interaction term is positive and statistically significant.

average retirement incentive due to stale returns within the PERS account balance that month. Finally, we interact the fraction of coworkers facing the same retirement benefit calculation as employee *i* in month *t* with the average fraction of retirement-eligible workers facing this retirement benefit calculation who retire in month *t*. This interaction term is our new variable of interest.

In the first column of Table 6, we report coefficients for the linear probability model:

$$\Pr(retire_{ijkt}) = \left(fracsame_{-ijkt} \times \overline{retire}_{kt}\right)\alpha + (fracsame_{-ijkt})\gamma + X_{ijkt}\beta + \eta_{kt} + \delta_{jt} + \varepsilon_{ijkt}$$

where $frac\_same_{-ijkt}$ is the fraction employee i's retirement-eligible coworkers at employer j, facing retirement benefit k, in month t, $\overline{\text{retire}}_{kt}$ is the fraction of retirement-eligible employees facing retirement benefit k that retire in month t (measured across all employers), and X_{ijkt} contains many of the control variables from Table 5, including all of employee *i*'s individual retirement incentives. Including a separate fixed effect for each retirement benefit calculation-date combination (η_{kt}) allows us to control for the average impact of benefit-specific retirement incentives on retirements in month *t* (and causes $\overline{\text{retire}}_{kt}$ to drop from the regression). Because we are focused on the interaction term, we are also able to include a separate fixed effect for each employer-date combination (δ_{jt}). By controlling for the average propensity of the employees of employer *j* to retire in month *t,* we are able to control for any employer-date specific shocks—something that we were not able to control for in Table 5. (On the other hand, we can no longer include the fraction of employee i's coworkers that retire in month *t*, or any other variable that varies solely at the employer-date level.) Standard errors are clustered on employer.

If employees are disproportionately more likely to respond to their retirement incentives when more coworkers face the same incentive, α will be positive. Indeed, the estimated coefficient on the interaction term in column (1) is positive and statistically significant (p-value of 0.000). It is also economically significant. Following Bertrand, Luttmer, and Mullainathan, we estimate that PERS employees are 89.6% more likely to respond to their aggregate retirement incentives than they would be in the absence of any peer effects.[24] The fact that employees are significantly more likely to respond to incentives when more of their coworkers face the same incentives strongly suggests that peer effects reflect the diffusion of information about retirement incentives.

The test in column (1) assumes that employee *i*'s peer group is best defined by her retirement benefit calculation or, alternatively, that any employee is equally likely to talk about retirement with any other employee. In the remaining columns of Table 6, we include interaction terms based on alternative definitions of employee *i*'s coworkers.[25] In column (2), we include the fraction of coworkers who are the same gender as employee *i* in employer *j* in month *t*, the average fraction of coworkers who are the same gender as employee *i* that retire (from any employer) in month t, and the interaction between these variables. The coefficient estimate on the interaction term is negative and statistically indistinguishable from zero, while the coefficient estimate on the original retirement benefit calculation interaction term is almost identical to the one in column (1). In column (3), we include an interaction term based on the fraction of coworkers who are the same gender and face the same retirement benefit calculation as employee *i*. Relative to column (1), this specification allows for the possibility that employees are more likely to discuss retirement incentives with coworkers of their own gender. While the estimated coefficient on this interaction term is positive, it is statistically indistinguishable from zero. Moreover, it has little impact on the size or significance of the original interaction term.

Police and fire officers have their own, more generous versions of the *DCDB* and *DB* benefit calculations, and may be more likely to interact with other police and fire officers than with general employ-

---

[24] To calculate the multiplier in column (1) of Table 6 as $\sum_{k=\{DB,DCDB,DC\}} frac_k \left(1/\left(1-\alpha(fracsame_k)\right)-1\right)$ which depends on the average value of *fracsame* for each of the three retirement benefit calculations ($fracsame_{DB}$, $fracsame_{DCDB}$, and $fracsame_{DC}$), and the fraction of retirees whose retirement benefits are determined by DB, DCDB, and DC ($frac_{DB}$, $frac_{DCDB}$, and $frac_{DC}$). When we interact retirement benefit calculation type with job type, for example, the number of categories doubles from {*DB, DCDB, DC*} to {*DB, DCDB, DC*} x {PF, not PF}.

[25] When testing for peer effects in the decision by university employees to participate in a supplemental tax-deferred retirement savings account, Duflo and Saez (2002) argue that a priori restrictions on which coworkers are peers can be used to help identify peer effects. They construct subgroups based on gender, years of service, age, faculty versus staff, and academic department. Because we are focused on the retirement timing decision, we do not attempt to construct subgroups based on years of service or age, but we do construct subgroups based on gender, police and fire versus normal, and employer (which is our analog to department).

ees. Therefore, in the remaining columns of Table 6, we distinguish police and fire officers from other employees. In column (4), we include the fraction of coworkers who have the same job type as employee i in employer j in month t, the average fraction of coworkers who are have the same job type as employee i that retire (from any employer) in month t, and the interaction between these variables. The coefficient estimate on the new interaction term is positive, but statistically indistinguishable from zero, while the coefficient estimate on the retirement benefit calculation interaction term is slightly attenuated, but remains economically and statistically significant.

In column (5), we include an interaction term based on the fraction of coworkers who have the same job type and face the same retirement benefit calculation as employee *i*. This final specification allows for the possibility that police and fire officers are more likely to respond to their own retirement incentives when more of their police and fire officer coworkers face the same retirement incentives, and that the same is true for general employees. Indeed, the estimated coefficient on this final interaction term is positive and statistically significant. In contrast, the estimated coefficient on the original interaction term falls sharply and loses statistically significant at conventional levels (p-value of 0.112). In other words, whereas the findings in the earlier columns suggest that peers groups can be defined as those coworkers facing the same retirement benefit calculation in month *t*, the findings in column (5) suggest that peer groups are better defined as coworkers with the same job type who are facing the same retirement benefit calculation. When we focus solely on the interaction term based on job type and retirement benefit calculation in column (5), we estimate that PERS employees are 40.1% more likely to respond to aggregate retirement incentives than they would be in the absence of peer effects. In column (6), when we drop the original interaction term from the regression, the social multiplier increases from 40.1% to 73.0%.

5.3.4. Are Peer Effects Helpful or Harmful to Employees?

Above we find evidence of peer effects in the retirement timing decision using two different identification strategies. In this section, we ask whether peer effects are likely to increase or decrease employee welfare. There are two cases to consider. The first is that peer effects reflect the diffusion of information about shared retirement incentives. In this case, so long as the information is accurately conveyed, we would expect little harm. The second case is that peer effects reflect herding behavior on the part of retirees. In this second case, how peer effects impact employee welfare depends on the extent to which an employee's optimization problem resembles that of her coworkers. The fact that the peer effects we identify are concentrated among coworkers who face the same retirement incentive in the same month suggests that they arise from the diffusion of information about retirement incentives, and that coworkers understand when they face the same the incentives.

Nevertheless, some employees may mistakenly respond to retirement incentives that they do not actually face. For example, recent studies find that financial literacy rates are lower for women (e.g., Lusardi and Mitchell (2007) and Lusardi and Tufano (2008)) and for those earning lower wages (e.g., Campbell (2006) and Levy and Seefeldt (2008)). To shed light on potential welfare consequences, we estimate reduced form regressions for different samples of retirement-eligible employees. The specification that we estimate in Table 7 is similar to the one estimate in Table 5, except that we replace the fraction of employee *i*'s coworkers retiring in month *t* with three instrumental variables: (a) the average retirement incentive of employee i's coworkers in January and February arising from stale returns; (b) the average retirement incentives of employee *i*'s coworkers in the twelve months leading up to the reduction in retirement benefits in July 2003; (c) the fraction of employee *i*'s coworkers with a birthday in month *t*. To the extent that individuals primarily mimic peers whose retirement incentives are aligned with their own, we expect our measures of average retirement incentives within each employer and month to strongly predict *DC* retirements, weakly predict *DCDB* retirements (since *DCDB* benefits are a linear combination of the *DC* and *DB* retirement benefit calculations), but to not predict *DB* retirements. Therefore, in each column, we restrict the sample to employees who are eligible to retire under either *DB, DCDB,* or *DC*. Columns (1)-(3) focus on the full sample of retirees, columns (4)-(6) focus on employees whose annual salary is in the both quartile of all PERS employees (within the calendar year), and columns (7)-(9) focus on female employees.

Looking across the columns in Table 7, we find no evidence of employees responding to incentives they do not face. The estimated coefficients on all three of the instrumental variables are statistically indistinguishable from zero in all three of the specifications that focus on employees who are eligible for the *DB* retirement benefit calculation. In contrast, the estimated coefficients on the instrument measuring retirement incentives from stale returns is positive and statistically significant from zero in all three of the specifications that focus on employees who are eligible for the *DC* retirement benefit calculation. In other words, the reduced form regressions reveal that coworker retirement incentives only matter when they match the employee's own retirement incentives, which is consistent with what we find in Table 6. The fact that the retirement incentives we study do not apply to the *DB* benefit calculation may also help to explain why adjusted R-squared is so much lower when we restrict the sample to those eligible to retire under *DB* (e.g., 2.02% in column (1) versus 7.45% in column (3)).

6. Structural Changes to PERS Since 2003[26]

In the spring of 2003, PERS found itself with a $17 billion funding gap. In response to this gap, PERS established a third tier of pension benefits, called the Oregon Public Service Retirement Program (OPSRP), for employees hired after August 29, 2003. OPSRP lowered the payout factor used in the DB benefit formula from 1.67% to 1.50%, and increased the normal retirement age from 60 to 65. These changes reduced the generosity of the DB benefit formula. More significantly, PERS eliminated the DC benefit formula. Instead, employee retirement contributions were directed into individual retirement ("IAP") accounts in which employees receive market returns and, therefore, bear market risk. In other words, for new employees, PERS became a system in which employer contributions fund a traditional defined benefit retirement benefit and employee contributions are invested just as in a traditional defined contribution retirement plan. It is an open empirical question whether this reduction in expected retirement benefits, which reduced the expected pension costs of employers, lowered the average quality of

[26] The sources for this discussion are web-based documents available from the PERS website. They include "The Oregon Public Employees Retirement System History: The first 60 Years," published by PERS on July 6, 2010. "Public Employee Retirement in Oregon: Where does the system stand and where could Oregon go from Here?," prepared by ECONorthwest for The Chalkboard Project and The Oregon Business Council on August 31, 2007.

new state and local employees.[27]

Breaking from precedent, the legislature also made several changes to PERS that reduced the expected retirement benefits of existing Tier1 and Tier 2 employees. First, the retirement account underlying the DC benefit formula was closed to new contributions. While existing investments in the regular and variable options continued to earn returns, the absence of new contribution reduced the expected account balances at retirement. In addition, new regulations required PERS to regularly update the actuarial equivalency factors used to convert retirement account balances into initial monthly retirement benefits. As we document above, the well-publicized reduction in actuarial equivalency factors effective July 1, 2003 contributed to the large number of retirements in the first half of 2003. Finally, employee contributions, which had formerly been placed into the regular and variable investment options, were directed into the same "IAP" retirement account as employees hired into OPSRP. On these contributions, existing employees also bear all of the market risk. As a result of these changes, the likelihood that the *DC* benefit formula provides the maximum retirement benefit has declined substantially. While over 85% of retirees retired under *DC* in 2003, just over 50% did so in 2010.[28] In 2005, PERS was required to retroactively change the annual return that it credited to retirement accounts in 1999 from 20.00% to 11.33%. The reductions in benefits for those who had already retired were implemented through reduced COLAs.

In total, the 2003 changes significantly reduced the level of underfunding. According to the actuarial report by Mercer, these changes improved the funded status from 88% to over 100% in retroactive calculations applied to 2001. In Figure 4, taken from the Mercer report, PERS was more than 90% funded before the financial crisis of 2008. The fraction of funded liabilities fell below 80%, because of the financial crisis, but reportedly exceeded 86% as of December 31, 2010.

---

[27] We explored the idea of testing whether Oregon public schools were less able to attract high-quality teachers after 2003, but were unable to obtain any proxies for teacher quality before or after 2003. Even basic measures that might allow us to measure teacher shortages, such as teacher-to-student ratios are unavailable from the Department of Education before 2004.

[28] Despite the widespread belief that the impact of the 2008 financial crisis on retirement assets forced employees to delay retirements, Goda, Shoven, and Slavov (2010) find only modest evidence that market returns delay retirement. The impact of market returns on the decision to retire is a potentially interesting research question to explore within PERS, as the impact of market returns on retirement account balances varies from Tier 1 to Tier 2 to OPSRP.

To address concerns about the solvency of PERS, the legislature created three tiers of public employee retirement benefits, and raised concerns in the minds of employees that retirement benefits could be reduced further in the future. Determining whether Oregon's current pension plan impacts its ability to recruit high-quality employees is complicated by the fact that public pensions in other states must take steps to eliminate similar funding gaps (Novy-Marx and Rauh (2011)).

7. Conclusion

In this paper, we provide evidence on the costs of a hybrid pension plan from the perspective of an employer. Not surprisingly, offering employees both the certainty of a defined benefit pension plan and the option to earn higher retirement benefits when market returns are high is costly. Over our sample period, this option increased the *ex post* costs of providing pension benefits by more than 50% relative to a counterfactual traditional defined benefit pension plan, increasing PERS pension obligations by $7 billion. Moreover, at a time when the emphasis is on encouraging employees to work longer and retire later (Goda, Shoven, and Slavov (2009)) we find that the DC benefit option encourages early retirements. We also find that fluctuations in retirement benefits contribute to retirement waves. For example, we observe 5,217 employees retire in the first six months of 2003, the period before PERS benefit formulas were adjusted to reflect the increased life expectancies of retirees. The highest number we observe in a full year is 4,314 in 1999, the year before the last known rate benefit calculation was eliminated. These lumpy retirements resulting from changes to PERS are likely to have generated significant administrative costs for employers, and, in some cases, may have disrupted the provision of public services.[29]

It is worth noting that there is a distinction between the expected level of retirement benefits and the form in which those benefits are delivered to employees. Rather than offer a hybrid plan, PERS could have offered a traditional DB pension plan and used the payout factor to increase pension generosity. Doing so, would have increased the expected benefits for all retirees—not simply those whose careers

[29] For example, the newspapers carried stories of firefighters and teachers and other public employees claiming that the impending changes to PERS forced them to retire in 2003. See, for example, "Pension Changes Prompt Early Retirement for State workers in Corvallis, OR," *Oregonian*, August 4, 2003, and "Oregon Public Employee System Puts Retirees in Work Predicament," Oregonian, September 11, 2003.

happened to coincide with periods of higher-than-average equity market returns.[30] And, a traditional DB pension plan would have discouraged early retirements relative to the hybrid pension plan. One potential argument in favor of the hybrid pension plan is that, if we expect stock returns to be higher when inflation is higher, it insures employees against a situation in which the inflation rate is high but the growth rate in wages is low. However, this insurance is costly for employers to provide, and may not be the most cost-effective way to compete for high-quality employees. This begs the question of whether and how much changes to PERS have impacted Oregon's ability to hire high-quality employees. For example, Oregon should ideally weigh the costs savings associated with OPSRP against any reduction in teacher quality resulting from lower pension benefits. Quantifying the impact of pension generosity on employee quality is a challenging but important area for future research.

[30] Of course, increasing the payout factor while holding employee contributions into the plan constant necessarily increases the expected level of underfunding, as discussed in Novy-Marx and Rauh (2011).

Appendix. Brief History of Changes to PERS

The history of the PERS plan reflects the countervailing tensions between providing competitive pension benefits and managing the costs of providing and managing those benefits.[31] PERS came into existence on July 1, 1946. At the time, it was argued that an orderly pension system would help Oregon state and local employers compete more effectively for employees. It initially resembled a DC plan, with employees contributing into an account that earned interest, but with retirement payments from the State capped at $125 per month. In 1953, PERS employees began contributing into Social Security. In 1967, PERS became a hybrid system, combining DC-style and DB-style benefits into a single benefit formula. Specifically, PERS began to calculate the retirement benefits of new and existing employees using the DCDB ("Formula plus annuity") benefit formula. In the same year, PERS began investing up to 10% of its portfolio in equities.

As quoted in the introduction, Governor Tom McCall argued that benefits for Oregon state employees were hampering the State's ability to attract and retain the talented employees that it needed to prosper. Between the late 1960s and the early 1980s, as a result of perceived labor market pressures and periods of high inflation, PERS increased employee's expected retirement benefits. In 1969, employees were given the choice between two investment options. The "regular" option guaranteed a minimum return of 5.5% per year, whereas the "variable annuity" option invested more heavily in U.S. and international equity. PERS also added an annual cost of living adjustment to retirement benefits calculated under the existing DCDB benefit formula. In 1973, PERS increased the maximum annual COLA from 1.5% to 2.0%. In 1979, in lieu of increasing nominal wages, employers began to "pick up" the 6% employee contribution on behalf of their employees. Because these changes increased the generosity of the PERS pension plan, between 1978 and 1981, the actuarial firm working for PERS issued warnings about a potential underfunding problem. In 1981, the DB benefit formula ("Full Formula") was introduced, and the DCDB formula was discontinued for new employees.

---

[31] Our summary in this section is based on the document "The Oregon Publc Employees Retirement System History, The First 60 Years," which was published by PERS on July 6, 2010.

In 1994, Ballot Measure 8 passed which eliminated the 6% employer contribution and guaranteed minimum return of 8% per year offered by the "regular" investment option. However, in 1996, the Oregon Supreme Court overturned Ballot Measure 8 for violating the contract clause of the U.S. Constitution. The basic argument was that PERS could not change the expected retirement benefits of existing employees. In response, "Tier 2" retirement benefits were established for employees hired after December 31, 1995. The normal retirement age was increased from 58 to 60, and the guaranteed return of 8% per year in the "regular" investment option was eliminated.

During the late 1990s, PERS employees began to retire in waves. One likely explanation was the political uncertainty created by ongoing court cases and proposed legislation. Another explanation, for which we find strong empirical support, is that the use of stale returns to calculate employee retirement account balances generated lumpy retirements. There is anecdotal evidence that these lumpy retirements had real costs. Beginning in 1997, Oregon school districts began reporting teacher shortfalls because they were unable to replace all of the retiring teachers. The use of the "last known rate" to calculate retirement account balances was eliminated in January 2000.

In 2003, PERS took several steps to close a $17 billion funding gap. Effective January 2003, PERS began offering a full lump sum payout option. Because PERS life annuity payments were better than actuarially fair when compared to the existing partial lump sum payout option (Chalmers and Reuter (2012)), this option had the potential to reduce underfunding. Effective July 2003, PERS replaced its old actuarial equivalency factor tables with tables that reflected the longer life expectancies of its existing employees. Because this change reduced life annuity payments under the DC and DCDB benefit formulas, it created strong incentives for some employees to retire before July 2003. We find strong empirical support that employees respond to this incentive.

Finally, PERS established a third tier of pension benefits (OPSRP) for employees hired after August 29, 2003. OPSRP lowered the payout factor used in the DB benefit formula from 1.67% to 1.50%. More significantly, it eliminated the DC benefit formula. Instead, employee contributions are directed into individual retirement accounts in which employees receive market returns. It is an open empirical question whether lower retirement benefits under OPSRP as compared to PERS Tier 2 lowered the average quality of new state and local employees.

References

Brown, Kristine, and Ron Laschever, 2011, "When They're Sixty-Four: Peer Effects and the Timing of Retirement," *American Economic Journal: Applied Economics* (Forthcoming)

Campbell, John, 2006, "Household finance," *Journal of Finance* 61, 1553-1604.

Chan, Sewin and Ann Huff Stevens, 2004, "Do changes in pension incentives affect retirement? A longitudinal study of subjective retirement expectations," *Journal of Public Economics* 88, 1307-1333.

Chan, Sewin and Ann Huff Stevens, 2008, "What you don't know can't help you: Pension knowledge and retirement decision-making," *Review of Economics and Statistics* 90, 253-266.

Chalmers, John, and Jonathan Reuter, 2012. "How Do Retirees Value Life Annuities? Evidence from Public Employees." *Review of Financial Studies* (Forthcoming).

Choi, James David Laibson, and Brigitte Madrian, 2005a, "$100 Bills on the Sidewalk: Violations of No-Arbitrage in 401(k) Accounts," *NBER Working Paper No. 11554*.

Choi, James, David Laibson and Brigitte Madrian, 2005b, "Are Empowerment and Education Enough? Under-diversification in 401(k) Plans," *Brookings Papers on Economic Activity* 2005(2), 151-198.

Coile, Courtney and Jonathan Gruber, 2007, "Future Social Security Entitlements and the Retirement Decision," *Review of Economics and Statistics* 89, 234-246.

Duflo, Esther, and Emmanuel Saez, 2002, "Participation and Investment Decisions in a Retirement Plan: The Influence of Colleagues' Choices." *Journal of Public Economics* 85, 121-148.

Duflo, Esther, and Emmanuel Saez, 2003, "The Role of Information and Social Interactions in Retirement Plan Decisions: Evidence from a Randomized Experiment," *Quarterly Journal of Economics* 118, 815-842

Farhi, Emmanuel and Stavros Panageas, 2007, "Saving and Investing for Early Retirement: A Theoretical Analysis," *Journal of Financial Economics* 83, 87-122.

Goda, Gopi Shah, Shoven, John B. and Slavov, Sita N., 2009, Social Security Policy in a Changing Environment: Removing the Disincentives in Social Security for Long Careers. NBER Book Chapter. Available at http://ssrn.com/abstract=1875377.

Goda, Gopi Shah, Shoven, John B. and Slavov, Sita N., 2010, Does Stock Market Performance Influence Retirement Intentions? NBER Working Paper No. w16211. Available at http://ssrn.com/abstract=1648011.

Gustman, Alan and Thomas Steinmeier, 2001, "Imperfect Knowledge, Retirement and Saving," Dartmouth College Working Paper 01-11, July 2001.

Hong, Harrison, Jeffrey Kubik, and Jeremy Stein, 2004, "Social Interaction and Stock Market Participation," *Journal of Finance* 59, 137-163.

Levy, Helen and Kristin Seefeldt, 2008, "How Do Lower-Income Families Think About Retirement?" University of Michigan working paper.

Lusardi, Annamaria and Peter Tufano, 2008, "Debt Literacy, Financial Experience, and Overindebtedness," Harvard Business School working paper.

Madrian, Brigitte and Dennis Shea, 2001, "The Power of Suggestion: Inertia in 401(k) Participation and Savings Behavior," *Quarterly Journal of Economics* 116, 1149-1187.

Manski, Charles, 1993, "Identification of exogenous social effects: the reflection problem," *Review of Economic Studies* 60, 531-542.

Novy-Marx, Robert, and Joshua Rauh, 2011, "Public Pension Promises: How Big Are They and What Are They Worth?," *Journal of Finance* 66, 1207-1245.

Sacerdote, Bruce, 2001, "Peer Effects with Random Assignment: Results for Dartmouth Roommates," *Quarterly Journal of Economics* 116, 681-704.

Samwick, Andrew, 1998, "New evidence on pensions, social security, and the timing of retirement," *Journal of Public Economics* 70, 207-236.

Stanton, Richard, 2000, "From Cradle to Grave: How to Loot a 401(k) Plan," *Journal of Financial Economics* 56, 485-516.

Stock, James H and David A. Wise, 1990, "Pensions, the Option Value of Work, and Retirement," *Econometrica* 58, 1151-1180.

Sundaresan, M. Suresh and Fernando Zapatero (1997), "Valuation, Optimal Asset Allocation and Retirement Incentives of Pension Plans," *Review of Financial Studies* 10, 631-660.

Figure 1a. Time-varying retirement incentives resulting from changes to AEFs, 1992-2003

	Exogenous Variation in AEFs	Implications for Annuitized DC Benefits	Implications for Annuitized DB Benefits
1/1/1992 12/31/1996	From the beginning of our sample period through 12/31/1996, annuity factor updated once per year, in same month as member's birthday	Incentive to retire decreases in months immediately prior to member's birthday	None
1/1/1997 6/30/2003	On 01/01/1997, new AEFs adopted; AEFs in same month as member's birthday increased modestly for those aged 40 to 54; AEFs now updated monthly	Incentive for younger members to postpone retirement until after 01/01/1997 Eliminates incentive to try to retire in same month as member's birthday	None
7/1/2003 12/31/2003	Effective 07-01-03, significantly lower AEFs adopted	Strong incentive to retire prior to 07/01/2003	None

Figure 1b. Time-varying retirement incentives resulting from stale returns, 1992-2003

	Exogenous Variation in DC Account Balance	Implications for Annuitized DC Benefits	Implications for Annuitized DB Benefits
1/1/1992 12/31/1999	From the beginning of our sample period through 12/31/1999, regular and variable account balances were calculated using **"last known rate" (LKR)**	When LKR exceeds expected return based on most recent financial return data, incentive to retire When LKR falls below expected return based on most recent financial return data, incentive not to retire	None
1/1/2000 12/31/2003	Effective 01/01/2000, calculate regular and variable account balances using actual YTD returns	Eliminates retirement incentives based on stale returns	None

Figure 2a. Fluctuations in DC Benefits

Monthly Return from Retiring Today vs. Waiting for New "Last Known Rate"

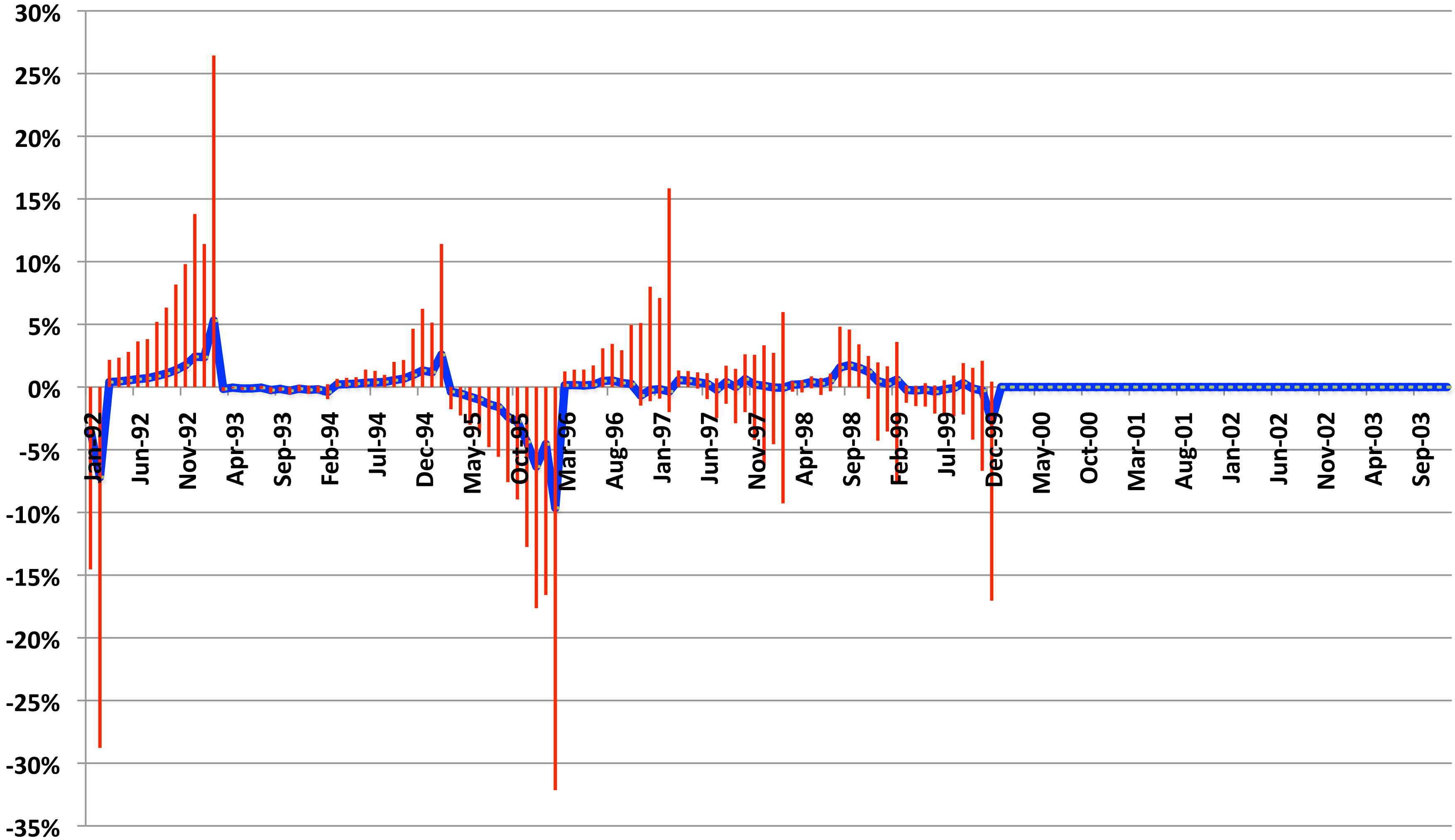
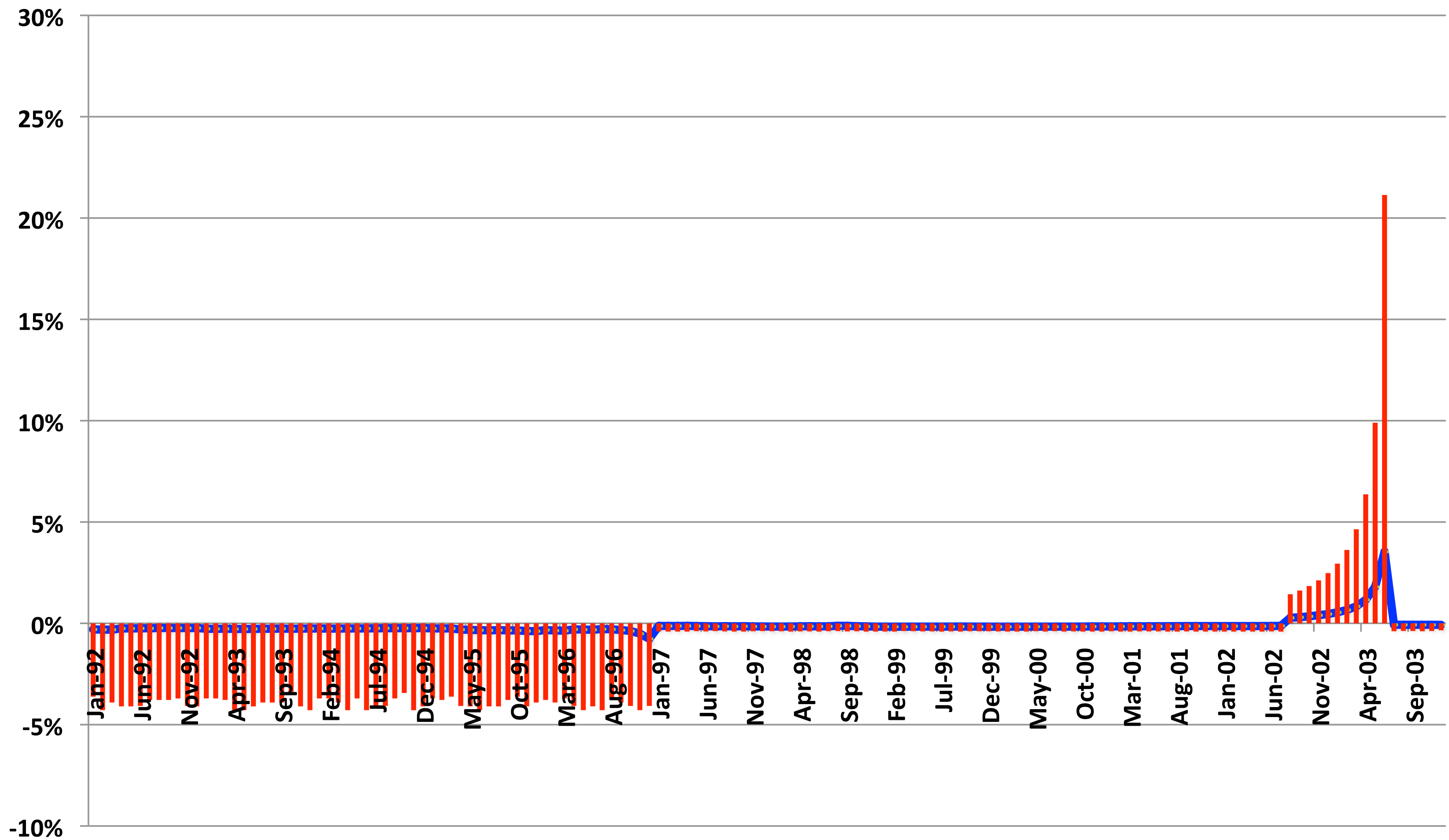


Figure 2b. Fluctuations in DC Benefits

Monthly Return from Retiring Today vs. Waiting for New Annuity Factor



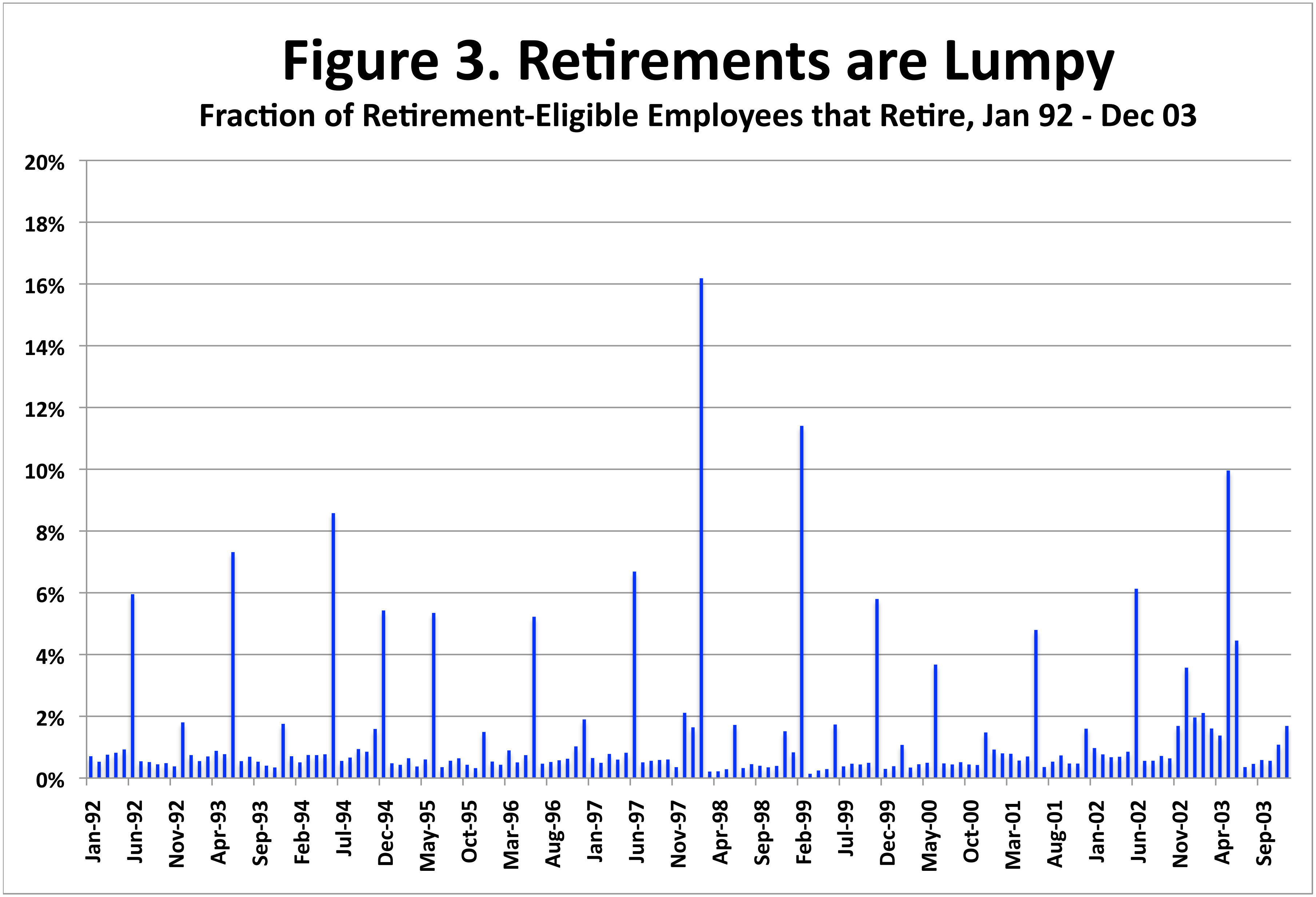
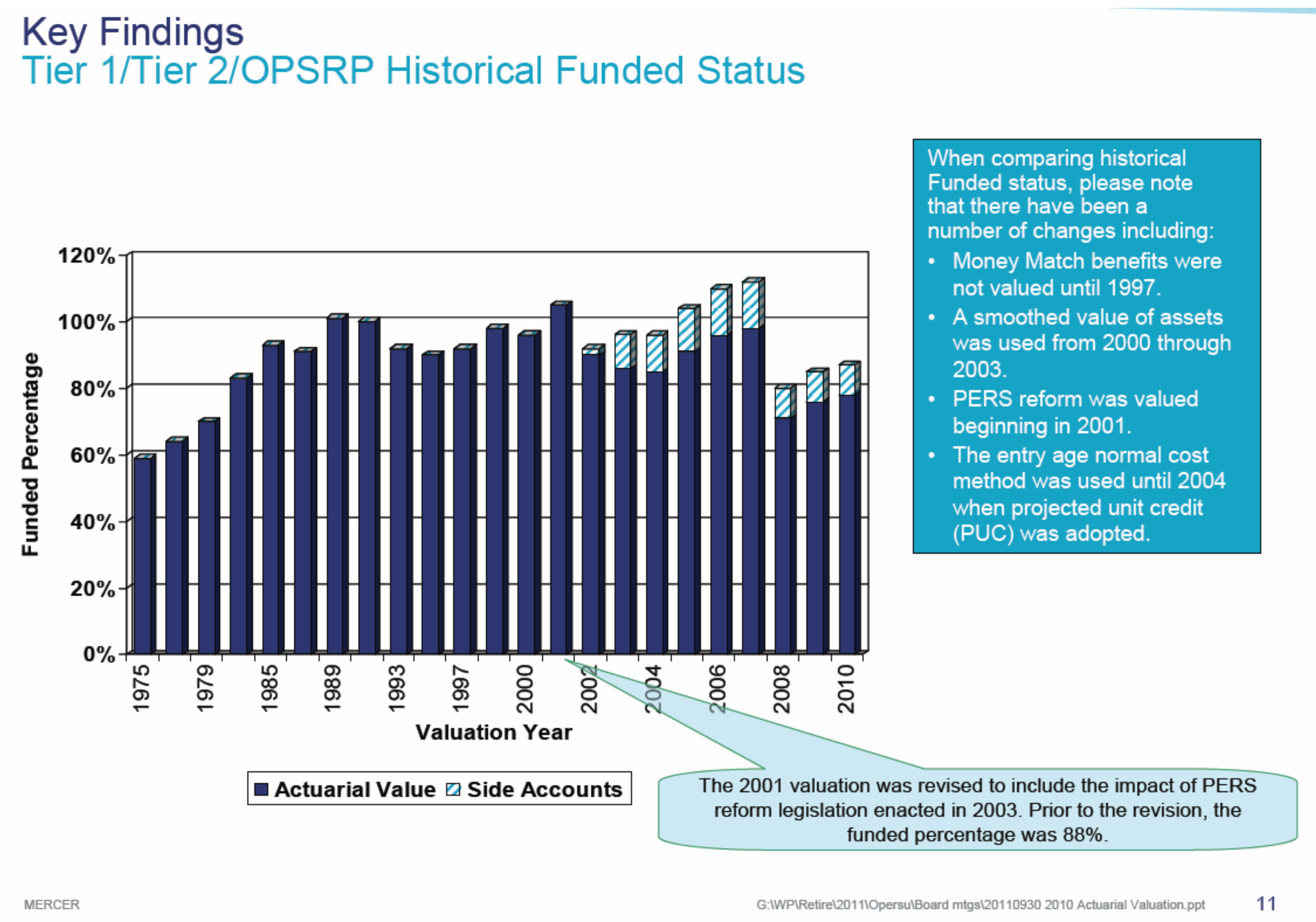


Figure 3. Retirements are Lumpy
Fraction of Retirement-Eligible Employees that Retire, Jan 92 - Dec 03
20%
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
Jan-92
Jun-92
Nov-92
Apr-93
Sep-93
Feb-94
Jul-94
Dec-94
May-95
Oct-95
Mar-96
Aug-96
Jan-97
Jun-97
Nov-97
Apr-98
Sep-98
Feb-99
Jul-99
Dec-99
May-00
Oct-00
Mar-01
Aug-01
Jan-02
Jun-02
Nov-02
Apr-03
Sep-03

Figure 4. The Impact of Structural Changes to PERS on the Level of Underfunding



Source: "December 31, 2010 Actuarial Valuation Oregon Public Employees Retirement System," presentation on September 30, 2011, by Mercer.

Table 1. Annual Employee-Level Summary Statistics, 1990-2003

	EMPLOYED & ELIGIBLE TO RETIRE NORMAL (#)	EMPLOYED & ELIGIBLE TO RETIRE EARLY (#)	AVERAGE MONTHLY SALARY PAST 12 MONTHS ($)	REPLACE-MENT RATE (%)	YEARS OF SERVICE (# years)	AGE (# years)	FEMALE (%)	POLICE OR FIRE (%)	PERS TIER 2 (%)	*DCDB* BENEFITS (%)	*DC* BENEFITS (%)
Panel A. Eligible to Retiree											
1990	7,724	1,266	$2,319	0.27	15.1	59.1	54.7%	5.7%	0.0%	49.6%	21.8%
1991	8,061	1,424	$2,454	0.33	15.3	59.1	54.4%	6.0%	0.0%	24.7%	57.7%
1992	8,266	1,402	$2,587	0.29	15.4	59.0	54.9%	6.4%	0.0%	41.8%	27.6%
1993	8,554	1,602	$2,694	0.30	15.5	59.0	55.7%	6.4%	0.0%	31.6%	39.0%
1994	8,516	2,282	$2,809	0.30	15.6	58.9	56.1%	6.8%	0.0%	32.1%	34.0%
1995	7,937	1,141	$2,794	0.36	15.2	58.7	56.5%	6.9%	0.0%	8.9%	73.0%
1996	8,839	1,475	$2,928	0.33	15.6	58.7	56.6%	7.5%	1.1%	14.0%	58.8%
1997	9,381	1,768	$3,055	0.38	15.7	58.5	56.7%	8.0%	3.8%	7.3%	73.5%
1998	9,495	2,469	$3,177	0.39	15.6	58.4	57.1%	7.9%	6.9%	4.8%	79.5%
1999	9,114	2,247	$3,239	0.39	14.9	58.3	57.9%	8.1%	11.4%	3.4%	83.0%
2000	9,123	1,055	$3,299	0.37	14.5	58.3	58.8%	8.1%	15.5%	2.7%	78.3%
2001	10,734	1,653	$3,442	0.37	14.8	58.3	59.4%	7.7%	18.5%	3.0%	70.4%
2002	11,634	2,503	$3,593	0.36	15.0	58.3	60.0%	7.0%	21.0%	3.0%	63.9%
2003	11,439	3,295	$3,667	0.33	14.8	58.3	60.5%	6.7%	24.1%	3.0%	58.9%
Panel B. Choose to Retire											
1990	1,266	240	$2,801	0.35	18.9	60.6	52.4%	4.7%	0.0%	59.7%	19.7%
1991	1,424	283	$2,994	0.41	19.3	60.5	49.8%	5.7%	0.0%	41.1%	45.7%
1992	1,402	276	$3,183	0.38	19.5	60.6	49.2%	6.8%	0.0%	52.6%	29.0%
1993	1,602	353	$3,351	0.41	19.7	60.5	51.0%	6.1%	0.0%	42.1%	41.6%
1994	2,282	493	$3,506	0.41	20.6	60.0	53.9%	7.5%	0.0%	46.0%	34.6%
1995	1,141	313	$3,260	0.45	18.8	60.4	54.1%	4.3%	0.0%	17.7%	67.2%
1996	1,475	310	$3,581	0.44	19.9	60.0	53.0%	6.5%	0.2%	25.4%	56.6%
1997	1,768	470	$3,735	0.50	20.4	59.7	55.0%	8.6%	0.4%	15.6%	72.7%
1998	2,469	1,138	$3,866	0.58	21.3	59.2	55.0%	6.5%	0.8%	7.6%	86.1%
1999	2,247	1,215	$4,019	0.59	20.9	58.6	55.0%	7.5%	1.4%	6.1%	88.2%
2000	1,055	614	$4,093	0.56	19.2	58.7	54.5%	7.3%	4.5%	4.3%	88.0%
2001	1,653	695	$4,303	0.58	20.6	58.8	57.0%	7.9%	4.1%	5.2%	84.7%
2002	2,503	1,125	$4,534	0.60	21.7	58.7	57.7%	6.8%	4.2%	4.9%	84.3%
2003	3,294	2,022	$4,490	0.56	21.2	58.5	59.0%	6.6%	4.5%	4.8%	82.2%

Note: The unit of observation is retirement-eligible employee i in year t. For employees who do not retire in year t, variables are measured in December. For employees who retire, variables are measured in the month of retirement.

Table 2. Retirement benefits owed to new retirees, January 1990 - December 2003

	Number of Retirements		Average Replacement Rate (ignoring Social Security)		Implicit Payout Factor		PV Retirement Benefits Owed New Retirees ($ millions)		PV of Actual Benefits relative to PV of Benefits Capped at DB
	DB	DCDB or DC	Capped at DB	Additional Benefit	Capped at DB	Additional Benefit	Capped at DB	Additional Benefit	
1990	388	1,386	31.5%	4.4%	1.70%	0.39%	317.6	44.5	114.0%
1991	261	1,747	32.3%	9.2%	1.68%	0.57%	391.8	115.6	129.5%
1992	357	1,644	33.2%	6.1%	1.69%	0.37%	451.2	81.0	118.0%
1993	394	1,929	32.9%	8.3%	1.69%	0.45%	591.1	152.4	125.8%
1994	639	2,722	34.5%	7.3%	1.69%	0.39%	799.3	169.5	121.2%
1995	270	1,501	30.7%	14.3%	1.66%	0.76%	386.0	190.6	149.4%
1996	398	1,795	32.8%	12.0%	1.69%	0.63%	526.3	194.1	136.9%
1997	315	2,261	34.0%	16.9%	1.69%	0.81%	682.5	344.0	150.4%
1998	263	4,051	34.7%	24.0%	1.68%	1.10%	1,297.7	895.2	169.0%
1999	231	3,957	33.9%	25.9%	1.70%	1.10%	1,253.9	963.1	176.8%
2000	146	1,846	31.5%	25.6%	1.69%	1.12%	536.1	439.9	182.1%
2001	277	2,475	34.1%	25.3%	1.67%	1.11%	889.9	658.4	174.0%
2002	454	3,920	35.8%	25.8%	1.67%	1.10%	1,660.0	1,174.7	170.8%
2003	795	5,518	34.5%	22.7%	1.65%	1.01%	2,459.3	1,593.1	164.8%
Total	5,188	36,752	33.8%	18.3%	1.68%	0.86%	12,242.4	7,016.0	157.3%

Note: This table decomposes the initial monthly retirement benefits of new retirees into the monthly benefit calculated using the DB formula, and any additional benefit arising from the availability of the DCDB and DC formulas. For example, the average replacement rate of retirees whose maximum benefit is based on the DB formula is 33.8%, while the average replacement rate of retirees whose maximum benefit is based on the DCDB or DC formula is 52.1% (33.8% plus 18.3%). The implicit payout factor measures what the payout factor would have needed to be in the DB formula to generate the same monthly benefit. For those retiring under DB, the average implicit payout factor reflects the mixture of retirements by normal employees, for whom the payout factor is 1.65%, and police and fire, for whom it is 2.00%. "PV Benefits Owed New Retirees" sums the expected present value of the retirement benefits owed to each retiree. We use retiree i's gender and age at retirement and life tables from the Social Security Administration for 2004 to determine the probability that she receives each future monthly payment, we assume an constant annual cost of living adjustment of 2.00%, and we use the prevailing yield on 10-year U.S. Treasury notes as our discount rate. The last column shows that the expected present value of retiree benefit payments are 57.3% higher than they would have been if retirement date choices were held constant and monthly benefits were calculated using the DB formula.

Table 3. Distribution of Retirement Ages, by Benefit Type, 1990-2003

Age at Reitrement	Retires with DB Benefits			Retires with DCDB Benefits			Retires with DC Benefits		
	#	%	Cum. %	#	%	Cum. %	#	%	Cum. %
< 55	69	2.0%	2.0%	279	5.1%	5.1%	1,051	4.5%	4.5%
55	144	**4.1%**	6.0%	236	**4.3%**	9.5%	4,000	**17.3%**	21.8%
56	153	4.3%	10.4%	264	4.8%	14.3%	2,294	9.9%	31.8%
57	216	6.1%	16.5%	474	8.7%	23.0%	2,360	10.2%	42.0%
58	542	**15.3%**	31.8%	1,101	**20.2%**	43.2%	2,941	**12.7%**	54.7%
59	313	8.9%	40.7%	560	10.3%	53.5%	1,630	7.0%	61.7%
60	289	8.2%	48.8%	480	8.8%	62.3%	1,437	6.2%	67.9%
61	316	8.9%	57.8%	506	9.3%	71.6%	1,587	6.9%	74.8%
62	566	**16.0%**	73.8%	654	**12.0%**	83.6%	1,841	**8.0%**	82.7%
63	230	6.5%	80.3%	244	4.5%	88.1%	807	3.5%	86.2%
64	203	5.7%	86.0%	201	3.7%	91.8%	768	3.3%	89.6%
65	238	**6.7%**	92.8%	256	**4.7%**	96.5%	1,019	**4.4%**	94.0%
66	92	2.6%	95.4%	75	1.4%	97.9%	337	1.5%	95.4%
67	58	1.6%	97.0%	41	0.8%	98.6%	227	1.0%	96.4%
68	31	0.9%	97.9%	27	0.5%	99.1%	200	0.9%	97.3%
69	24	0.7%	98.6%	20	0.4%	99.5%	163	0.7%	98.0%
70	24	0.7%	99.2%	10	0.2%	99.7%	140	0.6%	98.6%
> 70	27	0.8%	100.0%	17	0.3%	100.0%	330	1.4%	100.0%
All	3,535			5,445			23,132		

Note: This table reports the number of employees retiring with benefits calculated using the DB, DCDB, and DC formulas, by age at retirement. We begin with the sample of retirees described in Table 1 Panel B. However, to facilitate comparisons across benefit types, we exclude 3,017 retirees who were first hired on or after January 1, 1996, or who were police or fire officers. This leaves us with a sample retirees for who the early retirement age is 55 and the normal retirement age is 58 (unless the employee has 30 years of service before age 58).

Table 4. Linear Probability Model Predicting Retirement Date, 1990-2003

Dependent Variable:	*1 if employee i retires on date t, 0 otherwise*				
Sample:	**All members**	**Female = 1**	**PF = 1**	**Age >= 62**	**Birth Month = 1**
Estimation:	**OLS**	**OLS**	**OLS**	**OLS**	**OLS**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Replacement rate of total life annuity benefit	3.451 ***	3.080 ***	2.774 ***	0.045	6.704 ***
	[0.189]	[0.219]	[0.734]	[0.324]	[0.527]
EPV benefit of waiting until t*	0.003	0.002	-0.009	-0.021 ***	-0.001
	[0.002]	[0.002]	[0.006]	[0.005]	[0.007]
Incentive due to stale returns x {Mar-Dec}?	-0.045	-1.373	-2.975	-2.653	-10.489 **
	[0.890]	[1.007]	[4.009]	[3.137]	[4.173]
Incentive due to stale returns x {Jan-Feb}?	11.663 ***	13.259 ***	0.479	21.268 ***	12.362 ***
	[0.875]	[1.173]	[2.564]	[2.563]	[3.026]
Incentive due to changes in AEFs x ('90-'96}?	7.707 **	4.010	38.824 **	37.811 ***	
	[3.298]	[3.214]	[17.190]	[7.667]	
Incentive due to changes in AEFs x {'03}?	87.156 ***	100.436 ***	86.192 ***	67.265 ***	101.373 ***
	[5.659]	[6.652]	[23.697]	[8.853]	[14.987]
Eligible for early retirement -- month 1	0.009	0.198	-1.169 **		-2.000 ***
	[0.224]	[0.264]	[0.503]		[0.711]
Eligible for early retirement -- months 2-12	-1.179 ***	-0.952 ***	-1.977 ***		0.280
	[0.131]	[0.124]	[0.356]		[0.275]
Eligible for early retirement -- month 13+	-0.496 ***	-0.397 ***	-1.311 ***		1.275 ***
	[0.081]	[0.079]	[0.214]		[0.220]
Eligible for normal retirement -- month 1	3.032 ***	2.311 ***	10.123 ***	-1.678	3.341 ***
	[0.330]	[0.311]	[1.894]	[2.217]	[0.341]
Eligible for normal retirement -- months 2-12	0.331 ***	0.098	1.100 ***	-1.371 **	0.939 ***
	[0.078]	[0.080]	[0.360]	[0.602]	[0.238]
Birth month?	0.878 ***	0.702 ***	0.567 ***	2.664 ***	
	[0.092]	[0.105]	[0.182]	[0.168]	
Member dies in months 1-12?	0.819 ***	0.774 ***	0.473	1.026 **	1.215
	[0.191]	[0.258]	[0.566]	[0.405]	[0.804]
Member dies in months 13-48?	0.210 ***	0.125	0.340	0.079	0.744 **
	[0.055]	[0.087]	[0.313]	[0.154]	[0.299]
Years of Service	0.036 ***	0.043 ***	0.017	0.160 ***	0.056 ***
	[0.005]	[0.006]	[0.022]	[0.011]	[0.015]
Unemployment rate within county	-2.647 ***	-2.527 ***	-0.353	-2.178	-5.411 **
	[0.941]	[0.912]	[2.831]	[1.932]	[2.483]
Female?	-0.049 *		0.038	-0.417 ***	-0.326 ***
	[0.025]		[0.063]	[0.067]	[0.092]
Police or Fire Fighter?	-0.033	-0.089		0.289	-0.332
	[0.092]	[0.114]		[0.258]	[0.268]
PERS Tier Two?	0.022	0.062	0.192		-0.463 ***
	[0.039]	[0.048]	[0.142]		[0.135]
Full life annuity calculated under DB	-0.081 *	-0.024	-0.241	-0.415 ***	-0.520 ***
	[0.045]	[0.034]	[0.172]	[0.132]	[0.154]
Full life annuity calculated under DC	-0.258 ***	-0.151 ***	-0.480 ***	-0.255 *	-0.744 ***
	[0.036]	[0.037]	[0.141]	[0.137]	[0.153]
Separate fixed effect for each age (in years)?	Yes	Yes	Yes	Yes	Yes
Date-by-employer type FE?	Yes	Yes	Yes	Yes	Yes
N	2,407,980	1,386,758	174,114	358,392	221,770
R-Squared	0.0630	0.0659	0.0487	0.0752	0.0692

Note: Estimation is via OLS. Dependent variable equals 1 if employee i retires in month t and 0 otherwise. Employees who retiree in month t are dropped from the sample in month t+1. For consistency with tests for peer effects in later tables, the sample is restricted to employers with two or more employees eligible to retire in month t. Independent variables are described in section 5.2. Range in retirement incentives due to the use of stale returns in the retirement account balance calculation is plotted in Figure 2a. Range in retirement incentives due to changes to actuarial equivalency tables is plotted in Figure 2b. Standard errors are clustered on employer. Statistically significance at the 10-percent, 5-percent, and 1-percent levels is denoted by *, **, and ***. Coefficients are multipled by 100, so that 1.000 represents 1 percentage point.

Table 5. Linear Probability Model Testing for Peer Effects in the Choice of Retirement Dates, 1990-2003

Dependent Variable:	*1 if employee i retires on date t, 0 otherwise*					
Sample:	**All members**	**All members**	**All members**	**All members**	**All members**	**All members**
Estimation:	**OLS**	**IV**	**IV**	**IV**	**IV**	**IV**
Instruments:		**Stale Returns**	**AEFs '03**	**AEFs '90-'96**	**Birth Month**	**All**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Fraction of current employees retiring	27.024 ***	36.445 ***	15.364	-115.515	22.659 ***	20.454 ***
	[2.108]	[11.447]	[13.150]	[328.915]	[8.555]	[7.906]
Fraction of current employees retiring	0.092	0.067	0.122	0.465	0.103	0.109
from other employers in same county in month t	[2.981]	[2.586]	[3.469]	[8.906]	[3.163]	[3.256]
Fraction of non-retirement eligible employees	2.794 ***	2.507 ***	3.149 ***	7.138	2.927 ***	2.994 ***
leaving employer j in month t	[0.780]	[0.755]	[0.958]	[10.453]	[0.852]	[0.860]
Fraction of former employees retiring in month t	0.084	0.085	0.082	0.064	0.083	0.083
	[0.272]	[0.238]	[0.314]	[0.799]	[0.288]	[0.296]
Replacement rate of total life annuity benefit	3.421 ***	3.412 ***	3.432 ***	3.559 ***	3.425 ***	3.427 ***
	[0.186]	[0.185]	[0.187]	[0.347]	[0.188]	[0.187]
EPV benefit of waiting until t*	0.003	0.003	0.003	0.002	0.003	0.003
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Incentive due to stale prices x {Mar-Dec?}	0.001	0.016	-0.016	-0.219	-0.005	-0.008
	[0.868]	[0.860]	[0.876]	[1.190]	[0.869]	[0.871]
Incentive due to stale prices x {Jan-Feb?}	11.366 ***	11.262 ***	11.494 ***	12.933 ***	11.414 ***	11.438 ***
	[0.838]	[0.839]	[0.856]	[3.830]	[0.848]	[0.844]
Incentive due to changes in AEFs x ('90-'96?}	7.463 **	7.371 **	7.577 **	8.857	7.506 **	7.527 **
	[3.285]	[3.281]	[3.279]	[5.536]	[3.281]	[3.278]
Incentive due to changes in AEFs x {'03?}	86.433 ***	86.190 ***	86.733 ***	90.105 ***	86.545 ***	86.602 ***
	[5.564]	[5.533]	[5.571]	[10.935]	[5.591]	[5.571]
Eligible for early retirement -- month 1	0.003	0.001	0.006	0.033	0.004	0.005
	[0.225]	[0.225]	[0.225]	[0.238]	[0.225]	[0.225]
Eligible for early retirement -- months 2-12	-1.184 ***	-1.185 ***	-1.181 ***	-1.157 ***	-1.183 ***	-1.182 ***
	[0.131]	[0.131]	[0.131]	[0.147]	[0.131]	[0.131]
Eligible for early retirement -- month 13+	-0.498 ***	-0.498 ***	-0.497 ***	-0.486 ***	-0.497 ***	-0.497 ***
	[0.081]	[0.081]	[0.081]	[0.087]	[0.081]	[0.081]
Eligible for normal retirement -- month 1	3.030 ***	3.029 ***	3.031 ***	3.049 ***	3.031 ***	3.031 ***
	[0.328]	[0.326]	[0.329]	[0.356]	[0.328]	[0.328]
Eligible for normal retirement -- months 2-12	0.327 ***	0.325 ***	0.329 ***	0.351 ***	0.328 ***	0.328 ***
	[0.078]	[0.077]	[0.077]	[0.105]	[0.077]	[0.077]
Birth month?	0.876 ***	0.875 ***	0.877 ***	0.889 ***	0.876 ***	0.877 ***
	[0.092]	[0.092]	[0.092]	[0.093]	[0.092]	[0.092]
Member dies within next 12 months?	0.828 ***	0.832 ***	0.823 ***	0.772 ***	0.826 ***	0.825 ***
	[0.191]	[0.191]	[0.191]	[0.241]	[0.191]	[0.191]
Member dies within next 48 months?	0.212 ***	0.212 ***	0.211 ***	0.208 ***	0.211 ***	0.211 ***
	[0.055]	[0.055]	[0.055]	[0.059]	[0.055]	[0.055]
Years of service	0.035 ***	0.035 ***	0.036 ***	0.040 ***	0.035 ***	0.036 ***
	[0.005]	[0.005]	[0.005]	[0.013]	[0.005]	[0.005]
Unemployment rate in county	-1.809 **	-1.519 **	-2.167 **	-6.189	-1.943 **	-2.011 **
	[0.739]	[0.770]	[0.935]	[10.534]	[0.834]	[0.838]
Female?	-0.047 *	-0.046 *	-0.048 *	-0.063	-0.047 *	-0.048 *
	[0.025]	[0.025]	[0.025]	[0.046]	[0.025]	[0.025]
Police or Fire Fighter?	-0.012	-0.006	-0.020	-0.111	-0.015	-0.017
	[0.087]	[0.084]	[0.088]	[0.239]	[0.087]	[0.087]
PERS Tier Two?	0.029	0.032	0.025	-0.012	0.028	0.027
	[0.039]	[0.040]	[0.040]	[0.105]	[0.039]	[0.039]
Full life annuity calculated under DB	-0.073 *	-0.070	-0.077 *	-0.117	-0.075 *	-0.075 *
	[0.044]	[0.044]	[0.045]	[0.117]	[0.045]	[0.044]
Full life annuity calculated under DC	-0.253 ***	-0.250 ***	-0.255 ***	-0.286 ***	-0.254 ***	-0.254 ***
	[0.036]	[0.036]	[0.036]	[0.091]	[0.036]	[0.036]
Other individual controls from Table 2?	Yes	Yes	Yes	Yes	Yes	Yes
Separate fixed effect for each age (in years)?	Yes	Yes	Yes	Yes	Yes	Yes
Date-by-employer type FE?	Yes	Yes	Yes	Yes	Yes	Yes
N	2,407,980	2,407,959	2,407,959	2,407,959	2,407,959	2,407,959
Adj. R-Squared	0.0659	0.0656	0.0654		0.0659	0.0658

Note: Estimation is via OLS in column (1) and 2SLS in the remaining columns. The dependent variable and sample restrictions are the same as in Table 4. The instrument in column (1) is the average value of DC_delta for employee i's coworkers at employer j in month t. The instruments in columns (2) and (3) are the average values of AEF_delta for employee i's coworkers at employer j in month t, in the periods 2003 and 1990-1995, respectively. The instrument in column (4) is the fraction of coworkers with a birthday in month t. We use all four instruments in column (5). Additional control variables include the fraction of current employees retiring from other employers in same county in month t, the fraction of non-retirement eligible employees leaving employer j in month t, and the fraction of employer j's former employees retiring in month t. Standard errors are clustered on employer. Statistically significance at the 10-percent, 5-percent, and 1-percent levels is denoted by *, **, and ***. Coefficients are multipled by 100, so that 1.000 represents 1 percentage point.

Table 6. Interaction based test for Peer Effects, 1990-2003

Dependent Variable:	*1 if employee i retires on date t, 0 otherwise*					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Fraction coworkers with same **benefit type** (t) *	85.921 ***	85.974 ***	81.479 ***	77.792 ***	30.596	
Fraction all employees with same **benefit type** who retire (t)	[15.649]	[15.614]	[18.910]	[15.813]	[19.229]	
Fraction coworkers with same **benefit** type (t)	-0.812 ***	-0.811 ***	-0.618 ***	-0.766 ***	-0.442	
	[0.161]	[0.161]	[0.206]	[0.163]	[0.271]	
Fraction coworkers with same **gende**r (t) *		-3.090				
Fraction all employees with same **gender** who retire (t)		[5.843]				
Fraction coworkers with same **gender** (t)		-0.173 *				
		[0.091]				
Fraction coworkers with same **benefit type and gender** (t) *			7.523			
Fraction all employees with same **benefit type and gender** who retire (t)			[9.629]			
Fraction coworkers with same **benefit type and gender** (t)			-0.215 *			
			[0.116]			
Fraction coworkers with same **PF status** (t) *				13.568		
Fraction all employees with same **PF status** who retire (t)				[12.028]		
Fraction coworkers with same **PF status** (t)				-0.148		
				[0.236]		
Fraction coworkers with same **benefit type and PF status** (t) *					52.900 ***	76.236 ***
Fraction all employees with same **benefit type and PF status** who retire (t)					[18.442]	[14.296]
Fraction coworkers with same **benefit type and PF status** (t)					-0.373	-0.716 ***
					[0.279]	[0.159]
Controls and FE from T4 column (1)?	Yes	Yes	Yes	Yes	Yes	Yes
Date-by-benefit calculation-by-gender FE?	Yes	Yes	Yes	---	---	---
Date-by-benefit calculation-by-police/fire FE?	---	---	---	Yes	Yes	Yes
Date-by-employer FE?	Yes	Yes	Yes	Yes	Yes	Yes
N	2,407,959	2,407,959	2,391,709	2,407,959	2,402,768	2,402,768
Adj. R-Squared **(demeaned)**	0.0226	0.0226	0.0226	0.0226	0.0227	0.0227
Multiplier for interaction term introduced in column (1)	89.6%	89.7%	80.4%	73.5%	19.0%	---
Multiplier for additional interaction term	---	-1.6%	4.1%	14.0%	40.1%	73.0%

Note: Estimation is via OLS. We describe our empirical strategy, which is based on Bertrand, Luttmer, and Mullainathan (2000), and the calculation of the multiplier effect due to peer effects in Section 5.3.3. We include all of the independent variables from Table 5 that vary within employer-month, do do not report the estimated coefficients. Standard errors are clustered on employer. Statistically significance at the 10-percent, 5-percent, and 1-percent levels is denoted by *, **, and ***. Coefficients are multipled by 100, so that 1.000 represents 1 percentage point.

Table 7. Reduced form regressions of coworker incentives on individual retirements, 1990-2003

Sample:	**All Retirement-Eligible Employees**			**Low Income Employees**			**Female Employees**		
Retirement Benefit Calculation:	*DB*	*DCDB*	*DC*	*DB*	*DCDB*	*DC*	*DB*	*DCDB*	*DC*
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Individual's incentive due to stale prices		-1.236	22.559 ***		5.621	28.091 ***		-6.537 *	25.964 ***
		[3.200]	[1.651]		[10.562]	[3.063]		[3.760]	[2.256]
Individual's incentive due to changes in AEFs		97.553	51.495 ***		-179.332	77.708 ***		411.247 **	97.564 ***
		[114.736]	[11.356]		[235.952]	[13.603]		[189.199]	[13.984]
Coworkers' incentive due to stale prices	-1.779	3.548	10.359 **	-3.194	3.253	8.211 *	1.383	-0.279	12.900 **
	[2.239]	[3.664]	[5.201]	[3.874]	[5.674]	[4.890]	[2.830]	[4.827]	[6.529]
Coworkers' incentive due to changes in AEFs	0.977	289.331 **	42.900	32.946	1019.102	-7.203	-10.782	120.074	35.066
	[18.699]	[124.892]	[34.246]	[38.586]	[707.611]	[39.741]	[20.817]	[145.575]	[40.544]
Fraction of coworkers with birthday in month t	-0.104	0.492	0.453 **	0.026	-0.164	0.498 *	-0.100	-0.083	0.561 *
	[0.175]	[0.433]	[0.229]	[0.290]	[0.604]	[0.297]	[0.236]	[0.487]	[0.295]
Separate fixed effect for each age (in years)?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Date-by-employer type FE?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Date-by-benefit calculation FE?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	648,818	361,340	1,397,801	195,699	64,125	342,196	375,042	229,625	782,077
R-Squared	0.0202	0.0843	0.0745	0.0143	0.0625	0.0435	0.0225	0.0864	0.0770

Note: Estimation is via OLS. The dependent variable and sample restrictions are the same as in Table 4 with three exceptions. We include the actual retirement incentives that employees face due to stale returns and changes to AEFs in month t, as well as the average actual retirement incentives that their coworkers face in month t. In addition, because the actual retirement incentives apply most strongly to those retiring under DC and not at all to those retiring under DB, we estimate separate specifications for employees retiring under DB, DCDB, and DC. Finally, we further restrict the sample to employees with monthly salaries in the bottom quartile (measured within the calendar year) and females. Standard errors are clustered on employer. Statistically significance at the 10-percent, 5-percent, and 1-percent levels is denoted by *, **, and ***. Coefficients are multipled by 100, so that 1.000 represents 1 percentage point.