Is Retiree Demand for Life Annuities Rational? Evidence from Public Employees*

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Abstract

Oregon Public Employees Retirement System (PERS) retirees must choose between receiving all of their retirement benefits as life annuity payments and receiving lower life annuity payments coupled with a partial lump sum payout. For the median retiree, the expected present value of the incremental life annuity payments is 1.50 times the lump sum payout, and demand for lump sums is low. This pattern is consistent with value-maximizing decisions by retirees. However, when we exploit variation in the value of the incremental life annuity payments arising from how PERS calculates retirement benefits, we find robust evidence that demand for lump sum payouts is *higher* when the forgone life annuity payments are more valuable. We also find that demand for lump sum payouts is higher when the lump sum payout is "large," and when equity market returns over the prior 12 months are higher. Collectively, these findings suggest that retirees value incremental life annuity payments at less than their expected present value, either because they do not know how to accurately value life annuities or because they have strong demand for large lump sum payouts. In contrast, when we measure variation in the value of the incremental life annuity payments along a dimension that is easier for retirees to observe and interpret—poor health at retirement—we find evidence consistent with value-maximizing decision-making.

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1. Introduction

Because life annuities provide retirees with insurance against outliving their financial assets, economists have long argued that retirees should annuitize more of these assets (Yaari (1965) and Davidoff, Brown, and Diamond (2005)). Therefore, economists have struggled to explain the small size of the market for voluntary life annuities. On the one hand, this "under-annuitization puzzle" may reflect rational behavior not fully captured by standard life-cycle models (Yogo (2009)).[1] For example, it may reflect sensitivity to the high prices of life annuities arising from adverse selection in the voluntary market, access to sufficient life annuity income from other sources, such as Social Security, liquidity constraints, or bequest motives. On the other hand, the puzzle may reflect poor financial decision-making, resulting from financial illiteracy or behavioral biases (Brown (2009)). While rational and behavioral explanations have different welfare implications, attempts to distinguish between them have been hampered by both a lack of data on actual annuitization choices and a lack of variation in annuity pricing.[2]

To expand our understanding of the factors that influence demand for life annuities, we study the impact of plausibly exogenous variation in annuity pricing on the actual payout decisions of retirees within the Oregon Public Employees Retirement System (PERS). Our central research question is whether retiree demand for life annuity payments is higher when the value of those payments to the retiree is higher. An implicit but important, related question is whether retirees are able to accurately value life annuity payments.

Although our data are limited to Oregon public employees, they are well suited to an

[1] Yogo (2009) extends existing life-cycle models to include endogenous investments in health. He finds that the expected utility gains from access to life annuities vary from 13% to 18%, with smaller gains for retirees in poorer health. Although these gains are approximately half those estimated in prior studies (such as Mitchell, Poterba, Warshawsky, and Brown (1999)), they remain economically significant.

[2] Most evidence on demand for life annuities comes from surveys and simulations, rather than from data on actual annuitization choices. Brown (2001), Warner and Pleeter (2001), Finkelstein and Poterba (2004), and Previtero (2008) are notable exceptions, which we discuss below. Brown (2009) provides a nice overview of the potential rational and behavioral explanations for the under-annuitization puzzle.

investigation of these questions. First, each retiree faces the choice between lower monthly life annuity payments and a partial lump sum payment (the "partial lump sum" option) versus higher monthly life annuity payments and no lump sum payment (the "full life annuity" option). The choice between taking the partial lump sum payment and exchanging it for incremental life annuity payments is similar to the choice that a retiree faces in the private market for life annuities. Second, because there is no default payout option (i.e., retirees are not assigned to either payout option by default), we should observe a PERS retiree choosing the full life annuity option only when the value that she attaches to the incremental life annuity payments exceeds the value that she attaches to the partial lump sum payment.[3] Third, we are able to exploit cross-sectional and time-series variation in the value of incremental life annuity payments to study the actual payout choice of 41,940 retirees between January 1990 and December 2003.

However, PERS life annuity payments are much more valuable than those available in the private market. For the median retiree, the full life annuity option provides incremental life annuity payments with an expected present value of $1.50 per dollar in forgone partial lump sum payment. In contrast, the "money's worth" of life annuities offered by life insurance companies in the private market are between $0.80 and $0.90 (Mitchell, Poterba, Warshawsky, and Brown (1999)).[4] Therefore, to the extent that retirees can accurately value life annuity payments from PERS, we would expect to observe low demand for the partial lump sum option.

Overall, only 15.3 percent of PERS retirees choose a lump sum payout over the full life annuity option. This fraction is lower than one might surmise from a reading of the literature on

[3] Madrian and Shea (2001) show that default options can have a dramatic impact on financial choices. However, according to PERS, there is no default payout choice. Retirees are given a form that summarizes the life annuity and lump sum payouts under different options and asked to choose one. Blank forms are returned to retirees.

[4] The money's worth of a life annuity is the expected present discounted value of its payments, conditional on the annuitant's age and gender, divided by its price. Mitchell, Poterba, Warshawsky, and Brown (1999) find that the money's worth of life annuities in the voluntary market range from $0.80, using mortality tables for the population of retirees, to $0.90, using mortality tables for the subset of retirees who buy life annuities.

the under-annuitization puzzle, and it is especially striking given both that there is no default payout option, and that Oregon public employees are eligible to receive life annuity payments from Social Security. However, in Figure 1, we also observe significant time-series variation in the fraction of retirees choosing a lump sum payout, ranging from 8.1% in 1992 to 22.7% in 2000. If the low average demand for lump sum payouts reflects a rational response to the high average value of the full life annuity option, we would predict lower demand for lump sum payouts by those retirees for whom the value of the full life annuity option is higher.[5]

To test this prediction, we exploit several sources of variation in the value of PERS life annuity payments. Unlike insurance companies, PERS rarely adjusts its payments to reflect changes in retiree life expectancies or the risk-free rate. As a result of this inertia, we observe time-series variation in the median money's worth of the full life annuity option, from $1.16 in 1990 to $1.74 in 2002.[6] We also observe cross-sectional variation in money's worth because of interactions between the formulas used to determine life annuity and lump sum payments under the different payout options (which we describe below). For example, the level of the life annuity payment under the partial lump sum option ranges between 50.0% and 67.5% of the level of the life annuity payment under the full life annuity option. Finally, because money's worth assumes an average life expectancy, variation in health generates cross-sectional variation in the value of the forgone life annuity payments—variation which may be easier for retirees to observe and interpret. Following Finkelstein and Poterba (2004), we use data on which retirees die within 48 months of retirement to proxy for poor health at retirement.

[5] Brown (2001) uses data from the Health and Retirement Study on explain variation in the intentions of 869 households to annuitize defined contribution pension wealth. Because his starting point is a life-cycle model that predicts retirees will annuitize all of their wealth, which is not the case empirically, Brown tests for—and finds—a positive correlation between the expected benefit of annuitization and the intention to annuitize. Although several of our findings are consistent with his findings, he is not able to study the impact of variation in the value of life annuity payments on the demand for life annuities.

[6] When we divide the money's worth of a life annuities offered by PERS by the money's worth of a life annuity offered by TIAA-CREF, the ratio has a median of $1.63, and ranges from $1.25 in 1990 to $1.73 in 2002.

Our main findings are hard to reconcile with fully rational models of retiree behavior. Although life-cycle models predict that demand for incremental life annuity payments will rise with the value of these payments, we find the opposite. The higher the money's worth of the incremental life annuity payments—in either the cross-section or the time-series—the more likely the retiree is to choose the partial lump sum option over the full life annuity option. This (robust) finding suggests that retirees facing more valuable incremental life annuity payments either attach greater value to the lump sum payout or are more likely to underestimate the value of the incremental life annuity payments.

More generally, we find evidence that retirees attach less value to incremental life annuity payments than expected present value calculations suggest that they should. Rather, we find evidence that retirees use *ad hoc* rules. For example, we find that retirees are more likely to choose the partial lump sum option when the partial lump sum payment is "large" (in the top decile of lump sum payments offered to PERS retirees, measured in December 2003 dollars) or the incremental life annuity payment is "small" (in the bottom decile of incremental life annuity payments offered to PERS retirees, measured in December 2003 dollars), patterns consistent with retirees relying on less sophisticated valuation measures than money's worth.[7] More significantly, we find that demand for the partial lump sum option is increasing in recent stock market returns—even after we control for returns earned in the PERS retirement account—suggesting that retirees use the wrong discount rate to value life annuity payments, perhaps because they want to chase recent equity market returns.[8] Figure 1, suggests that the fraction of

[7] Since Lusardi and Mitchell's (2007) find that many households do not understand the basic financial tools necessary for good retirement decision-making, perhaps it should not be surprising that retirees do not calculate the expected present discounted value of the incremental life annuity payments.

[8] The idea that retail investors may chase past returns is not new. For example, Sirri and Tufano (1998) provide evidence of return chasing behavior by mutual fund investors. However, in that setting, Berk and Green (2004) argue that the behavior is not irrational.

retirees demanding a lump sum is associated with the returns on the prior 12-month returns to the S&P 500 index. In other words, while the low demand for lump sum payouts may reflect a general understanding that PERS life annuity payments are unusually valuable, the retirees who we study have an imperfect understanding of how to measure this value. The interesting exception is that retirees who die within 48 months of retirement are more likely to choose the partial lump sum payout, just as life-cycle models and existing evidence on adverse selection would predict.[9] In other words, retirees do respond to variation in the value of life annuity payments, but only when the variation is easy to observe and interpret.

Finally, we find evidence of an income effect. The higher the monthly life annuity payment under the partial lump sum option (which is the lowest life annuity payment available from PERS during most of our sample period) the more likely the retiree is to choose the partial lump sum payout. Although the value to the retiree of additional life annuity payments should fall with the level of already-annuitized wealth, it is worth repeating that the median PERS retiree forfeits $1.50 in expected present value per dollar of partial lump sum payout. On the other hand, we also find that demand for the partial lump sum option is lower for retirees earning high salaries, perhaps because they are less financially constrained or more financially literate.[10]

The findings that we just described apply to the majority of our sample period, where retirees are limited to the full life annuity and partial lump sum options. However, between December 2002 and December 2003, retirees were also given an option to receive all of their retirement benefits in the form of an immediate lump sum payment (the "full lump sum" option). During this 13-month period, we continue to find that demand for the partial lump sum is

[9] See, for example, the evidence of adverse selection in Mitchell, et al. (1999) and Finkelstein and Poterba (2004).
[10] Campbell (2006) shows that income is positively related to stock market participation. Although income is also positively correlated with education, the fact that Campbell finds education to matter after controlling for income suggests that our proxy for financial literacy is rather crude.

increasing in the value of the incremental life annuity payments. However, we simultaneously find that demand for the full lump sum option is *decreasing* in the value of the full life annuity payments. (In the middle of this period, PERS updated its benefit calculations to better reflect the life expectancies of its retirees, providing us with another source of variation in the value of life annuity payments.) One way to rationalize these opposite findings is that there are income and substitution effects at work. As described below, there is a strong positive correlation between the level of the life annuity payments under the full life annuity and partial lump sum options. Therefore, the more valuable the full life annuity payments, the more costly the full lump sum option, and the lower the demand for full lump sum payouts (i.e., a substitution effect). At the same time, the more valuable the full life annuity payments, the more valuable the life annuity payments under the partial lump sum option, and the lower the need for incremental life annuity payments if one chooses the partial lump sum option (i.e., an income effect).

The fact that retirees are willing to forgo valuable incremental life annuity payments in exchange for large lump sum payouts suggests an underlying demand for liquid retirement assets. To the extent that these results can be generalized to other retirees, the demand for liquid retirement assets, combined with limited knowledge of how to accurately value life annuities, likely help to explain the low demand for life annuities in the private market.

The remainder of the paper is organized as follows. In section 2, we describe the related empirical literature. In section 3, we describe pertinent features of the Oregon Public Employee Retirement System and provide summary statistics on variables of interest, including money's worth. In section 4, we study the extent to which demand for lump sum payouts varies with the value of the forgone life annuity payments. In section 4.1, we focus on the demand for the partial lump sum option relative to the full life annuity option. In section 4.2, we test for differences in

the demand for partial and full lump sum options. In section 5, we conclude.

2. Related Empirical Literature

Our findings complement those in three studies on the choice between life annuities and lump sums. Buetler and Teppa (2005) study the choice between life annuities and lump sums in the ten Swiss pension funds over a similar time period. They find that the majority of retirees choose life annuities over lump sums, but that there is variation in this fraction across funds. They also find that small account balances are less likely to be annuitized. More recently, Previtero (2008) studies the choice between life annuities and lump sums payouts using data from 108 defined benefit plans between 2002 and 2007. He finds higher demand for life annuities by females and older retirees, and by those retiring in months when recent stock market returns have been negative. We also find that differences in gender and recent stock market returns help to explain differences in demand for lump sum payouts. However, in contrast to these studies, because we focus on a single, large retirement plan, we are able to study the impact of plan-induced variation in the relative value of life annuity payments on the demand for lump sum payouts. Finally, based on a survey of 2,600 employees and 2,400 retirees in 2007, Watson Wyatt concludes "Most employees want a lump sum—if it's big enough."[11] We also find strong demand for lump sum payouts when the level of the payout is large.

Our paper also relates to Warner and Pleeter (2001), who study the choice between lump sum and (non-life) annuity payments in a sample of individuals separating from the military. Although annuities in their sample are also quite generous, they find strong demand for lump sum payouts, especially by enlisted personnel. The fact that we find high demand for generous life annuity payments by PERS retirees may reflect that the fact that military personnel have

[11] Watson Wyatt's "2007 U.S. Surveys of Older Employees' and Retirees' Attitudes Toward Lump sum and Annuity Distributions from Retirement Plans," is summarized in the article "Who Prefers Annuities? Observations About Retirement Decisions," published in April 2008 issue of *Watson Wyatt Insider*.

higher personal discount rates than public employees. Or, it may reflect the fact that whereas we study retirees with an average age of 58, they study military personal with an average age of 31, who may use the lump sum to prepare for a new career. Interestingly, we find that PERS retirees who are eligible to begin receiving Social Security benefits (because they are age 62 and older at retirement) are significantly less likely to choose a lump sum payout, perhaps because they are less likely to re-enter the labor force.

3. Overview of Oregon's Public Employees Retirement System

Our data come from the Oregon Public Employees Retirement System (PERS). PERS is the state agency responsible for administering the retirement plans for approximately 95% of the state and local public employees in Oregon. In 2006, PERS held nearly $56 billion in assets, making it the 22nd largest public or private pension fund in the United States. Employers covered by PERS include all state agencies, universities, and school districts; and almost all cities, counties, and other local government units.[12] Below, we outline the retirement plan features that inform our analysis, and we provide summary statistics for key variables.

3.1. Life Annuities versus Lump Sums

The PERS pension plan combines a traditional defined benefit plan with a defined contribution plan, and is funded by contributions from both employers and employees. Each month, employees contribute 6% of their salary into defined contribution-style retirement accounts. Throughout our sample period, employees have the option to invest 25%, 50%, 75%, or 100% of their contributions into the "regular" account, with the remainder invested into the riskier "variable" account. Employee contributions and the returns earned in the regular and variable accounts determine an employee's PERS retirement account balance. This account

[12] We exclude employees of public colleges and universities from our sample because they are allowed to opt out of PERS and into a traditional defined contribution plan. PERS chose to exclude politicians and judges.

balance determines the size of the partial lump sum payout. It is also an important determinant of the life annuity payments under the full life annuity and partial lump sum options.

The level of the full life annuity payment is automatically calculated as the maximum of three possible benefits: *DC* is a traditional defined contribution retirement benefit, *DB* is a traditional defined benefit retirement benefit, and *DCDB* is a hybrid benefit that equals half of *DC* plus more than half of *DB*.[13] In contrast, the life annuity payment associated with the partial lump sum option is calculated as the maximum of two benefits: half of the full life annuity payment under *DC* or slightly more than half of the full life annuity payment under *DB*. While a retiree must have contributed into PERS prior to September 1981 to be eligible for the full life annuity payment under *DCDB* (which is the case for 75.1% of the retirees we study), there is no eligibility requirement when calculating the life annuity payments associated with the partial lump sum option. In the appendix, we state the formula associated with each benefit, and show how variation generated by the PERS benefit calculation method impacts the values of the partial and full lump sum options.

By choosing the partial lump sum option over the full life annuity option, retiree *k* receives an immediate lump sum payment equal to the accumulated value of her contributions into the PERS retirement account, but also receives lower life annuity payments each month. Because there are three ways to calculate the full life annuity payments and two ways to calculate the life annuity payments associated with the partial lump sum option, the relative value of the incremental life annuity payments varies across retirees based on inputs into the retirement benefit calculation such as their salaries and years of service, the returns earned in their PERS retirement accounts, whether they are eligible for police and fire benefits, and whether they began contributing into PERS employer before September 1981. Importantly,

[13] PERS refers to the *DC, DB,* and *DCDB* options as "Money Match", "Full Formula", and "Formula plus Annuity".

while retirees should seek to maximize their retirement benefit, they should be indifferent about which formula yields the maximal benefit.

3.2. Retiree Characteristics and Retirement Benefits

Between January 1990 and December 2003, we observe the payout choices of 41,940 retirees between the ages of 50 and 70. In Table 1, we provide separate summary statistics for retirees whose full life annuity benefit is calculated using *DC* (68.1% of retirees), *DB* (12.4%), and *DCDB* (19.5%). Column (1) reports the number of retirees in each year, columns (2) through (8) summarize retiree characteristics that are inputs into one or more of the life annuity benefit formulas, and columns (9) and (10) report the (initial) monthly life annuity payments under the full life annuity and partial lump sum options. *Monthly Salary* (column (4)), PERS retirement *Account Balance* (column (5)), *Full Life Annuity* (column (9)), and *PLS Life Annuity* (column (10)) are converted to December 2003 dollars using the Consumer Price Index.

Although PERS automatically determines which life annuity formula applies to each retiree, the fact that columns (2) through (8) are inputs into these formulas results in significant differences between the retirees in the different panels of Table 1. For example, life annuity benefits calculated under *DC* are increasing in the level of the PERS retirement account balance, while benefits calculated under *DB* are not. Consequently, the average account balance ranges from $105,568 to $200,252 under *DC*, but from $28,598 to $58,381 under *DB*. Similarly, because there is no explicit early retirement penalty in the *DC* benefit calculation, retirees whose full life annuity is calculated under *DC* are significantly more likely to retire before reaching their normal retirement age, which is 55 for police and fire but 58 for virtually every other retiree we study. Between 1990 and 2003, the average retirement age under *DC* falls from 60.6 to 58.2. In contrast, the average retirement age under *DB* rises slightly, from 59.6 to 60.4. The decline in

the average retirement age of retirees under *DCDB* reflects the fact that this benefit is the most generous for police and fire retirees.

When retirees choose the partial lump sum option, they receive an immediate payment equal to the *Account Balance* (column (5)), but lower life annuity payments. In columns (9) and (10), we report the life annuity payments under the full life annuity and partial lump sum options. The difference is the incremental life annuity payment provided by choosing the full life annuity option. For example, for the typical retiree receiving full life annuity benefits under *DC* in 1995, the choice is between an initial monthly life annuity payment of $2,340, and an immediate payout of $136,169 and an initial monthly life annuity payment of $1,172 (which is $1,168 lower). For the typical retiree receiving full life annuity benefits under *DB* in 1995, the choice is between an initial monthly life annuity payment of $488, and an immediate payout of $20,876 and an initial monthly life annuity payment of $297 (which is $191 lower). In the next section, we quantify the tradeoff between the incremental life annuity payments and the lump sum payout.

3.3. Measuring the Value of PERS Life Annuity Payments

Following Mitchell, Poterba, Warshawsky, and Brown (1999), we define the "money's worth" of a life annuity as the expected present value of its future life annuity payments, per dollar of initial outlay. Given retiree k's choice between the full life annuity and partial lump sum options, the money's worth of her incremental life annuity payments is defined as:

$$MW^k = \left[\frac{A^k}{P^k}\right] \times \left[\sum_{t=1}^{T} \frac{(1+g)^{t-1} \times S_t^k}{(1+r_t)^t}\right] = \left[\frac{A^k}{P^k}\right] \times EPV_g^k \qquad (1)$$

where A^k is the initial level of the incremental life annuity payment to retiree k, P^k is the level of the (forgone) partial lump sum payment, S^k_t is the probability that retiree k does not die before receiving the payment in month t, g is the monthly growth rate in annuity payments, r_t is the

appropriate nominal discount rate for a payment to be received in month t, T is the number of months between k's current age and certain death, and EPV^k_g denotes the expected present value of retiree k receiving \$1.00 in month 1, \$1.00 (1+g) in month 2, …, until death. When the money's worth equals \$1.00, the tradeoff between the incremental life annuity payments and the partial lump sum payment is actuarially fair. In this case, risk neutral retirees will be indifferent between the two choices, but risk averse retirees will strictly prefer the incremental life annuity payments.

Typically, life annuity payouts are quoted in terms of actuarial equivalency factors, which state the (fixed, nominal) number of dollars paid out each month until death, per \$1000 in initial outlay. In our setting, we state the money's worth of incremental life annuity payments in terms of the actuarial equivalency factor that PERS would use under *DC,* multiplied by a factor, δ^k, to adjust for cases where the full life annuity and partial lump sum life annuity payments due to the retiree are not both calculated under *DC*. Formally,

$$MW^k = \left[\delta^k \times \frac{AEF^k_{PERS}}{\$1{,}000}\right] \times EPV^k_g \qquad (2)$$

where AEF_{PERS} increases with retiree age, to reflect declining life expectancies, but does not vary with gender.[14] As shown in the Appendix, when retirees are eligible for *DCDB*, δ^k is never less than one.

In Table 2, we calculate the money's worth of PERS incremental life annuity payments for male retirees who turn 65 in January 1990, January 1991, …, January 2003.[15] We also

[14] Finkelstein, Poterba, and Rothschild (2009) study the transfer from males to females that results from not allowing actuarial equivalency factors to vary with gender. These restrictions apply to the market for pension annuities in the United Kingdom, Oregon's Public Employees Retirement System, and TIAA-CREF, among others.

[15] When estimating the estimated present discounted value of life annuity payments for retiree k in month t, we use the yield on 10-year Treasury Notes on the first trading day of month t, and we use the mortality tables published by the Social Security Administration for 2004. The second assumption leads us to slightly overestimate the estimated

calculate the money's worth of the life annuity payments that these retirees would receive from TIAA-CREF in exchange for their partial lump sum payments. The PERS life annuities are significantly more generous than those available from TIAA-CREF (or the private market). For the retirees in Table 2, the PERS life annuity is always better than actuarially fair, with money's worth ranging from $1.14 in January 1990 to $1.65 in January 2003. In fact, in our sample of 41,940 retirees, the money's worth of the increment life annuity is better than actuarially fair for all but 145 retirees. In contrast, the money's worth of the life annuities offered by TIAA-CREF is never more than $0.92. We define the money's worth of the PERS life annuity relative to the TIAA-CREF life annuity as

$$\theta^k = \frac{\mathrm{AEF}^k_{\mathrm{PERS}} \times EPV^k_{2\%}}{\mathrm{AEF}^k_{\mathrm{TIAA}} \times EPV^k_{0\%}}.$$

Within Table 2, θ^k ranges from 1.30 to 1.92. Within our sample of retirees, θ^k ranges from 1.17 to 2.06, with an average value of 1.62.

The value of PERS life annuity payments has two sources. First, it reflects the fact that PERS life annuity payments increase by 2 percent per year while those offered by TIAA-CREF (and other life insurance companies) do not. This fact explains why the expected present values for PERS (column (2)) are uniformly higher than those for TIAA-CREF (column (5)), but it does not generate significant time-series variation in the value of PERS life annuity payments. The second source of in the value of PERS life annuity payments is the fact that whereas TIAA-CREF adjusts its actuarial equivalency factors each January, based on changes in annuitant life expectancy and the risk-free rate, PERS does not adjust its actuarial equivalency factors until July 2003. In the bottom row of Table 2, we show that the correlation between the yield on 10-

present discounted value in 1990 relative to 2003. We are in the process of obtaining data from TIAA on changes in the mortality of their members over our sample period.

Year U.S. Treasury Notes (the discount rate that we use to estimate expected present values) and TIAA-CREF's actuarial equivalency factors (column (4)) is 0.949. We also show that the correlation between the Treasury yield and the relative money's worth (column (9)) is -0.963. In other words, time-series variation in the risk-free rate generates significant time-series variation in the relative value of incremental life annuity payments from PERS.

3.4. Time-Series Evidence on Demand for Lump Sum Payouts

Overall, only 15.3% of retirees choose a lump sum payout over the full life annuity benefit. While this low demand for lump sum payouts is consistent with the fact that PERS incremental life annuity payments are significantly more valuable than those available in the private market, it is also consistent with alternative explanations. For example, the low demand for lump sum payouts might reflect the fact that those individuals with greater demand for annuitized retirement benefits are more likely to become public employees. Or, because PERS reports the monthly payment associated with each payout option rather than the implied rate of return, it might reflect the framing effect described in Brown, Kling, Mullainathan, and Wrobel (2008). Although we cannot measure the impact of these (time-invariant) alternatives on the average demand for lump sum payouts, they are unlikely to explain the significant time-series variation in the fraction of retirees choosing a lump sum payout that we observe in Figure 1.

To determine whether the low demand for lump sum payouts reflects the high value of the incremental life annuity payments, we study the extent to which demand for lump sum payouts falls with the money's worth of the incremental life annuity payments. In Table 3, we report the number of retirees, fraction of retirees choosing a lump sum payout, and money's worth of the incremental life annuity payments associated with choosing the full life annuity option for each year and benefit calculation. From January 1990 through November 2002, the

fraction choosing a lump sum payout reflects the fraction choosing the partial lump sum option; from December 2002 through December 2003, this fraction reflects both the partial and full lump sum options. For those retirees whose full life annuity benefits are calculated under *DB, DC, DB,* and *DCDB*, the average fractions choosing a lump sum payout are 20.7%, 15.9%, and 10.0%, respectively, while the median money's worth are $1.42, $1.55, and $1.34.

The time-series evidence based on correlations between median money's worth and demand for lump sums is also mixed. Within the sample of retirees retiring under *DB,* we observe a negative correlation of -0.550. Within the samples of retirees retiring under either *DC* or *DCDB*, however, the correlation coefficients are 0.293 and 0.387, suggesting that demand for partial lump sum payouts rises when the value of the incremental life annuity payments is higher. In the next section, we ask whether multivariate analysis allows us to unravel this puzzle.

4. Predicting Demand for Lump Sum Payouts

To test whether demand for lump sum payouts responds rationally to variation in the value of the forgone incremental life annuity payments, we analyze payout choices from two distinct time periods. First, using data from January 1990 to June 2002, we explore the impact of annuity values, market conditions, and retiree characteristics on the demand for the partial lump sum option. Then, using data from December 2002 to December 2003, when retirees also have the option to receive full lump sum payouts, we study the choice between the partial and full lump sum options.

4.1. Demand for Partial Lump Sum Payouts

The optimal decision rule is easily stated. Retiree *k* should choose the partial lump sum option whenever the partial lump sum payment increases her expected utility more than the incremental life annuity payments under the full life annuity option. In Table 4, we report

marginal effects from four logit models where the dependent variable equals one if retiree *k* chooses the partial lump sum option and zero if she chooses the full life annuity. To explore the relationship between the value of the incremental life annuity payments and demand for partial lump sum payouts, we include the money's worth of retiree k's incremental life annuity payments relative to the partial lump sum payout, several other measures of the relative value of the incremental life annuity payments, and the level of life annuity payments under the partial lump sum option. We also include retiree characteristics intended to proxy for life expectancy, risk aversion, and family structure; a separate fixed effect for each age; and recent equity returns inside and outside of the retiree's PERS retirement account. The first three specifications differ with respect to the measures used to measure the relative value of the life annuity payments that are forgone when choosing the partial lump sum option, and whether year fixed effects are included. The fourth specification is identical to the third, but the sample is restricted to female retirees. Standard errors are clustered on the year and month of retirement (e.g., June 1998).

A fundamental prediction of life-cycle models is that demand for partial lump sums should fall as the value of the forgone life annuity payments rises. However, the estimated coefficient on the natural logarithm of the money's worth of the incremental life annuity payments is positive and statistically significant in all four specifications. In other words, the more valuable the incremental life annuity payments, the more likely retirees are to choose the partial lump sum payment.[16] Similarly, when we replace the year fixed effects with the measure of the natural logarithm of the money's worth of PERS relative to TIAA-CREF, the estimated coefficient on the second money's worth-based measure is also positive and statistically

[16] Because we include age fixed effects, the cross-sectional variation in money's worth that we use to estimate this coefficient primarily comes from the subset of retirements for which the full life annuity benefit is calculated under DB. The reason, illustrated in Table A1, is that under DC and DCDB, money's worth is proportion to the PERS actuarial equivalency factor, which is a function of retiree age.

significant. In terms of economic significance, a one-standard deviation increase in the individual money's worth measure increases the probability of choosing the partial lump sum by less than 1 percentage point, while a one-standard deviation increase in the value of PERS life annuity payments relative to those available from TIAA-CREF increases the probability by more than 3 percentage points. Neither effect is easily reconciled with the view that retirees recognize and respond rationally to variation in the expected present value of life annuity payments.

In the third specification, we introduce several additional measures of the values of the incremental life annuity and partial lump sum payments. Two are intended to capture the possibility that retirees focus on the levels of the incremental life annuity payments and partial lump sum payouts rather than on the expected present value of the incremental life annuity payments relative to the partial lump sum payout. The first is a dummy variable that indicates whether the partial lump sum payout (measured in December 2003 dollars) is in the top 10% of those offered to PERS retirees, and the second is a dummy variable that indicates whether the incremental life annuity payments (measured in December 2003 dollars) are in the bottom 10% of those offered to retirees. The estimated coefficients on both variables are statistically and economically significant. Within the full sample, in column (3), retirees facing "large" lump sum payouts are 4.7 percentage points more likely to choose the partial lump sum payout, while those facing "small" incremental life annuity payments are 6.6 percentage points more likely to choose the partial lump sum payout. When we restrict the sample to female retirees, in column (4), the coefficient on "large" lump sum payouts decreases in economic and statistical significance (2.0 percentage points; p-value of 0.113), while the coefficient on "small" incremental life annuity payments is essentially unchanged (7.0 percentage points; p-value of 0.000). Although these results are consistent with retirees using less sophisticated (and more

salient) measures than money's worth to compare incremental life annuities and partial lump sums, including these *ad hoc* measures does not decrease the estimated coefficient on either money's worth measure.[17]

We also include variables that capture variation in money's worth based on ineligibility for the *DCDB* full life annuity benefits. Our empirical strategy is to test whether those retirees facing lower money's worth based on when they first contributed into PERS are more likely to choose the partial lump sum option. We include one dummy variable that identifies the 21.1% of retirees who are *DCDB*-ineligible (because they did not first contribute into PERS before September 1981) and another dummy variable that identifies the 10.1% of retirees for whom the money's worth of the incremental life annuity payments is lower than it would have been if the retiree had been eligible for *DCDB*.[18] Our prediction is that if demand for partial lump sums responds to money's worth, the 10.1% of retirees facing lower average money's worth (for a plausibly exogenous reason) will have higher average demand for partial lump sum payouts. Indeed, this is what we find within the full sample of retirees. Among female retirees, however, the effect is statistically indistinguishable from zero.

Because we estimate all of our money's worth measures assuming an average life expectancy (conditional on age and gender), they overstate the value of life annuity payments to someone in poor health. Following Finkelstein and Poterba (2004), we use *ex post* mortality to proxy for poor health at retirement. Consistent with traditional models of adverse selection, we find that demand for the partial lump sum option is approximately five percentage points higher among those who die within 48 months of retirement. In other words, when we measure variation in the value of the incremental life annuity payments along a dimension that is easy for

[17] The role of saliency in retirement choices is similar in spirit to the finding in Barber, Odean and Zheng (2005) that investors flows respond more stronger to fees that are more salient.
[18] In the appendix, we identify the range of *DC* and *DB* benefits under which this condition holds.

retirees to observe and interpret, we find evidence (qualitatively) consistent with value-maximizing decisions. However, given that 85 percent of PERS retirees choose the full life annuity option, in our setting, the impact of adverse selection on demand for lump sums is relatively small.[19]

To measure the impact of already-annuitized retirement benefits on the demand for incremental life annuity payments, all four specifications include the level of the life annuity payment under the partial lump sum option (measured in December 2003 dollars). Before the full lump sum option is added in December 2002, this is the lower bound on the life annuity payment from PERS. All four of the estimated coefficients are economically and statistically significant, with a one-standard deviation increase in life annuity payments ($879) increasing demand for the partial lump sum between 2.5 and 3.8 percentage points. In other words, while we find little evidence that demand for partial lump sums responds rationally to plan-driven variation in the value of the incremental life annuity payments, we find strong evidence of an "income effect" in that demand for partial lump sums increases with the level of life annuity payment that cannot be converted into a lump sum.

Given our evidence that retirees value incremental life annuity payments at less than their expected present value, we include two measures of recent equity market returns. The first is the return on the S&P 500 index over the prior 12 months and the second is the return earned in the PERS retirement account over the same period. Consistent with the pattern in Figure 1, we find a strong and statistically significant relation between returns on the S&P 500 index and demand for partial lump sum payouts. In the specifications that exclude year fixed effects, a one

[19] While our findings complement those in Finkelstein and Poterba (2004), it is worth noting that our settings are quite different. They test for adverse selection within a competitive market with multiple providers of life annuities and multiple dimensions along which these providers can compete for retirees. In contrast, we test for adverse selection in a setting in which there is a single non-profit provider that rarely adjusts the terms of its life annuities to reflect market conditions.

percentage point increase in the S&P 500 over the prior 12 months increases the probability of choosing the partial lump sum by approximately 15 basis points (p-value of 0.000), regardless of whether we focus on all retirees (column (3)) or female retirees (column (4)). Moreover, the link between S&P 500 returns and demand for partial lump sums survives the inclusion of the year fixed effects, although the economic and statistical significance are reduced (8 basis points; p-value of 0.050). In contrast, none of the marginal effects associated with the returns earned in the PERS account balance over the prior 12 months are statistically distinguishable from zero.[20]

One interpretation of the positive impact of recent S&P 500 returns on the demand for partial lump sum payments is that retirees use recent equity market returns to infer future equity market returns, leading them to discount future life annuity payments at this (not risk-free) rate. This interpretation is consistent with the (arguably irrational) return chasing behavior observed in the mutual fund industry (see, for example, Sirri and Tufano (1998)). A second interpretation is that higher recent equity market returns are associated with higher expected retirement benefits from other sources. Since we cannot observe the impact of equity market returns on a retiree's other sources of (defined contribution) retirement income, we cannot completely rule out this second interpretation. However, when we re-estimate the specification in column (3) using the 18,329 retirees with 20 or more years of service within PERS, the (unreported) marginal effects on the equity return measures are virtually identical to those reported in column (3). In other words, it appears that retirees overvalue the lump sum payout when recent equity market returns have been higher, perhaps because they (naively) overestimate the degree of serial correlation in equity market returns.

When we turn our attention to retiree characteristics, we find evidence that is more easily

[20] Chalmers, Johnson, and Reuter (2008) describe several features of the Oregon Public Employees Retirement System that reduce the correlation between the equity returns earned by the S&P 500 index and those posted to PERS retirement account balances, allowing us to separately estimate the impact of each return measure.

reconciled with rational financial decision-making. For example, we find that female retirees are approximately 5 percentage points less likely to choose the partial lump sum option. On the one hand, since PERS actuarial equivalency factors do not adjust for the longer life expectancies of females, this may constitute additional evidence of adverse selection. On the other hand, since gender-based differences in life expectancy are incorporated into the money's worth measures, the lower demand for lump sum payouts by female retirees either reflects a more qualitative understanding of the fact that PERS life annuity payments favor women, or gender-based differences in risk aversion. Our more-direct proxy for risk aversion is a dummy variable that indicates whether the retiree allocated a positive fraction of her employee contribution to the variable retirement account. Based on this proxy, the fraction of female retirees with a tolerance for risk is slightly lower than the fraction of male retirees (32.0% versus 35.0%). However, the marginal effect of a positive allocation to the variable account on the demand for a partial lump sum payout is virtually identical when we focus on the full sample of retirees (2.3 percentage points) and the sample of female retirees (2.2 percentage points).

The marginal effects on two other control variables may also capture differences in risk aversion. First, although police and fire officers are clearly less averse to some forms of risk than other retirees, we find that (male) police and fire officers are between 1.6 and 2.7 percentage points less likely to demand the partial lump sum. This difference either reflects the fact that police and fire officers expect to receive more life annuity payments from PERS because of their earlier retirement ages, but to an extent not already captured by money's worth, or that they are more averse to financial risk.[21] Second, we find that retirees choosing single (as opposed to joint) life annuities are significantly more likely to demand the partial lump sum.

[21] The marginal effect on the police and fire dummy variable is statistically insignificant when we restrict the sample to female retirees, but only 9.8% of the retirees are police and fire officers and only 10.8% of the police and fire officers are female.

Since joint life annuities continue to make payments until both the retiree and the retiree's beneficiary have died, we view the dummy variable indicating whether the retiree chooses a single life annuity as a proxy for being unmarried. Although Kotlikoff and Spivak (1981) and Brown and Poterba (2000) argue that single retirees should have lower demand for partial lump sums, we find the opposite. Within the full sample of retirees, those choosing single life annuities are 8.0 percentage points more likely to choose the partial lump sum. Within the sample of female retirees, the marginal effect is 4.9 percentage points. One interpretation of these results, in the spirit of Barber and Odean (2001), is that single retirees are less risk averse than married retirees, and that these effects are larger for male retirees. An alternative interpretation, consistent with the income effect we find, is that retirees whose spouses have their own retirement benefits are more likely to demand the partial lump sums.

A related retiree characteristic is the estimated percentage of the retiree's career spent working for PERS employers. The higher this fraction the lower the level of retirement benefits the retiree is likely to receive from sources other than PERS. Across all four specifications, we find a stronger negative relation between reliance on PERS retirement benefits and demand for partial lump sum payouts, although the relation is slightly weaker for female retirees, who may be more likely to have working spouses. Another variable that differs between the full sample of retirees and the sample of female retirees is the dummy variable indicating whether retiree k's salary is in the top quartile of those retiring in the same calendar year, which is our crude proxy for financial sophistication. Consistent with more highly paid retirees recognizing the abnormal value of the PERS incremental life annuity payments, we find that they are approximately 3 percentage points less likely to choose partial lump sums. However, this result appears to be driven entirely by male retirees since the marginal effect in the sample of female retirees is close

to zero. The final two variables related to retiree characteristics are dummy variables that indicate whether the retiree is retiring before her normal retirement age, or is eligible for "Tier 2" benefits (because she did not contribute into PERS before January 1997).[22] However, neither of these variables is statistically related to the decision to take a partial lump sum.

Overall, Table 4 presents several puzzling findings related to retirement payout choice. First, there is the robust, positive relation between the value of the forgone life annuity payments and demand for the partial lump sum. Second, there is the positive relation between lagged market returns and demand for partial lump sums. Third, there is the fact that demand for the partial lump sum option is highest among those choosing single life annuities. We view each of these findings as a challenge to models of rational economic behavior. On the other hand, we also find evidence that adverse selection and risk aversion impact demand for partial lump sum payouts in the ways that these models would predict. In addition, we find an "income effect" with respect to the demand for incremental life annuities, whereby demand for incremental life annuity payments declines with the level of life annuity payments under the partial lump sum option. To the extent that the positive relation between money's worth and demand for partial lump sums reflects an income effect, we should find a different relation between money's worth and demand for full lump sum payouts. In the next section, we test this prediction.

4.2. Demand for Partial versus Full Lump Sum Payouts

While demand for partial lump sum payouts is predicted to fall when the forgone life annuity payments are more valuable, we observe the opposite. Does this finding reflect poor financial decision-making or strong (but costly) demand for non-annuitized retirement benefits? To distinguish between these alternatives, we study demand for the full lump sum option. In

[22] Tier 2 members receive lower expected returns in their PERS retirement accounts and face higher normal retirement ages than other members, but only account for 0.35% of the retirees in our sample.

December 2002, PERS retirees were given the option to receive all of their retirement benefits in the form of a lump sum. By choosing the full lump sum option, retiree *k* receives a payout equal to two times her PERS retirement account balance (double the value of the partial lump sum payout), but does not receive any life annuity payments from PERS.

In Table 5, we report the fraction of retirees choosing the partial and (when available) full lump sum options between January 2002 and December 2003, as well as the median money's worth of each option. (The money's worth of the full lump sum option is the expected present value of the full life annuity payments divided by twice the PERS retirement account balance.) Between January 2002 and November 2002, before full lump sum payouts are permitted, 10.0% of retirees choose the partial lump sum option. In contrast, between December 2002 and December 2003, 7.2% choose the partial lump sum option and another 6.1% choose full lump sum option, suggesting that a significant fraction of PERS retirees value the full lump sum option. Furthermore, demand for lump sum payouts increases over this 13-month period. Between December 2002 and June 2003, when 5,944 of the 7,001 retirements occur, demand for partial lump sums (7.1%) and full lump sums (5.5%) are slightly below those for the full period. Between July 2003 and December 2003, however, demand for partial and full lump sum payouts increase to 7.9% and 9.6%, respectively.

The increased demand for lump sum payouts in the final six months of our sample period coincides with a well-publicized change in the PERS retirement benefit calculations.[23] Effective July 2003, PERS reduced its actuarial equivalency factors between 3.0% (for the youngest retirees in our sample) and 13.6% (for the oldest), significantly reducing the full life annuity payments of many retirees. The desire to retire before PERS reduced its actuarial equivalency

[23] Between January 1990 and June 2003, PERS adjusted its actuarial equivalency factors only once, making them 0.1% to 3.0% more generous for retirees under the age of 55. The change took effect on January 1, 1997, and only impacted 3.5% of our retirees, namely, police and fire officers retiring before their normal retirement age of 55.

factors likely helps to explain the surge in retirements through June 2003. The corresponding reduction in the money's worth of the partial and full lump sum options may also explain the increased demand for lump sum payouts.

In Table 6, to test whether demand for the full lump sum option rises or falls with the relative value of the forgone life annuity payments, we estimate two logit models. Although the changes in PERS actuarial equivalency factors are reflected in the money's worth of each option, we also test whether demand for lump sum payouts shifts up after PERS lowered its actuarial equivalency factors. Because of the short sample period, we drop market return measures, as well as the value of PERS life annuity measured relative to those from TIAA-CREF. Because retirees choosing the full lump sum option do not face the choice between single and joint life annuities, we also drop the single life annuity dummy variable. All of the standard errors reported in Table 6 are clustered on the year and month of retirement.

In column (1) we estimate an ordinary logit model where the dependent variable equals one when the retiree chooses the full lump sum over the partial lump sum, and the sample is restricted to the 925 retirees choosing either the partial or the full lump sum option. Here, the measure of interest is the natural logarithm of the expected present value of the life annuity payments under the partial lump sum option divided by the incremental lump sum payment, which equals the PERS retirement account balance. Interestingly, within this sample of retirees, more valuable incremental life annuity payments are associated with lower demand for full lump sum payouts. Moreover, the effect is economically and statistically significant; a one-standard deviation increase in the natural logarithm of money's worth is associated with a 4.9 percentage point reduction in the likelihood of choosing the full lump sum payout. Therefore, in contrast to our findings for partial lump sum payouts, the demand for full lump sum payouts is negatively

correlated with value of the forgone life annuity payments, just as theory would predict.

How can we reconcile this evidence with our prior evidence (from a non-overlapping sample) that demand for the partial lump sum option is positively correlated with the value of the forgone life annuity payments? One possibility is that retiree demand for full lump sums payouts responds to the value of the forgone life annuity payments, but when the life annuity payments associated with the partial lump sum option are "high enough," retirees are willing to forgo some life annuity payments in favor of liquid retirement assets. This quasi-rational explanation predicts that demand for partial lump sums should remain positively correlated with the value of incremental life annuity payments within the sample of retirees eligible for full lump sum payouts. To test this explanation, we estimate a multi-nominal logit that includes two measures of the value of PERS life annuity payments, in addition to the other explanatory variables in column (1). The first measure is the natural logarithm of the money's worth of choosing the full life annuity over the partial lump sum option, which we also include in Table 4. The second measure is the natural logarithm of the ratio of the money's worth of choosing the full life annuity over the full lump sum option minus the natural logarithm of the money's worth of choosing the full life annuity over the partial lump sum option. (Because the life annuity payments that a retiree forgoes under the full lump sum option are at least as large as those associated with the partial lump sum option, this second measure is always nonnegative.) In column (2a), we report the marginal effects for the choice of the partial lump sum option; in column (2b), we report the marginal effects for the choice of the full lump sum option.

Consistent with our prediction, we find that money's worth is a positive and statistically significant predictor of demand for the partial lump sum, but a negative and statistically significant predictor of demand for the full lump sum. In other words, when we estimate a logit

model that allows the impact of money's worth to vary across the choices, we find evidence that retirees view partial lump sum option, which leaves the retiree with positive life annuity payments, quite differently from the full lump sum option, which does not. We also find that the probability of choosing either lump sum option increases between 1.5 and 1.7 percentage points in the final six months of our sample period, even after controlling for the impact of the reduced actuarial equivalency factors on money's worth.

With respect to the retiree characteristics, the marginal effects in Table 6 are generally consistent with those reported in Table 4, based on a much larger sample of retirees. For example, in columns (2a) and (2b), we find that lower levels of risk aversion, measured by the allocation to the variable account, are associated with higher demand for both lump sum options. In addition, in column (2b), we find that female retirees, and those with relatively high salaries, are less likely to choose the full lump sum option. Finally, for two of the characteristics, we find interesting differences in the how they impact demand for partial and full lump sums. First, the fraction of the retirees' career spent with PERS employers, decreases demand for the full lump sum option. However, it also increases demand for the partial lump sum option. Second, "Tier 2" retirees (who first contributed into PERS no earlier than January 1997), are 3.3 percentage points less likely to demand the partial lump sum, but 11.2 percentage points more likely to demand the full lump sum. Because these retirees have no more than seven years of service with PERS by December 2003, the increased demand for full lump sum payouts may reflect less reliance on PERS for their retirement benefits than the typical "Tier 1" retiree.

5. Conclusion

Although life annuities provide valuable insurance against longevity, the private market for life annuities is small. One explanation for the low demand is that they are priced assuming

significant adverse selection, making them unattractive to the typical retiree. This explanation presupposes, however, that retirees recognize and respond to how life annuities are priced.

To shed new light on the demand for incremental life annuity payments, we study the actual retirement payout choices of Oregon public employees over 14 years. Our setting differs from the private market for life annuities in several interesting ways. First, for PERS retirees to receive all of their retirement benefits in the form of life annuity payments, they simply choose the full life annuity option. In contrast, the typical retiree needs to exert effort to participate in the voluntary market. Second, PERS life annuities are significantly more generous than those available in the private market. Third, until July 2003, PERS did not adjust the terms of its life annuity contracts in response to changing life expectancies and market conditions, making it relatively easy for us to identify factors that influence demand for life annuities.

The evidence that retirees understand how to value life annuity payments is weak. In general, we predict demand for lump sums to fall as the level of forgone life annuity payments rises. Given the generous nature of the PERS incremental life annuities, we might instead predict little relation between demand for lump sums and the value of the forgone life annuity payments. In contrast to both predictions, we find that demand for partial lump sum payouts increases with the value of the forgone life annuity payments. One way to rationalize this positive relation is to note that while retirees can directly observe the value of the lump sum payout it requires both effort and financial knowledge to observe variation in and accurately measure the value of the forgone life annuity payments. Indeed, controlling for money's worth, we find demand for lump sum payouts jumps when the lump sum payout is “large” or the incremental life annuity payment is “small.” In other words, to the extent that retirees use measures of annuity generosity to evaluate the partial lump sum option, these measures appear

unsophisticated. Moreover, the fact that demand for partial lump sum payouts is higher when lagged returns on the S&P 500 are higher suggests that retirees are confused about both the appropriate discount rate to use and the degree of serial correlation in equity market returns. At the same time, we find evidence that lower life expectancies (conditional on age) are associated with (slightly) higher demand for lump sum payouts. In other words, when we focus on a source of variation in the value of life annuities that is easily observed and interpreted by retirees, we find evidence consistent with rational financial decision-making (and the existing literature).

When we contrast demand for partial and full lump sum payouts, we find that demand for partial lump sum payouts rises with generosity while demand for full lump sum payouts falls. One way to rationalize the fact that annuity generosity has opposite effects on partial and full lump sum payouts, is that there are income and substitution effects at work. The more generous the life annuity benefits, the more costly the partial lump sum option but the lower the need for additional life annuity retirement income. Indeed, the fact that demand for partial lump sums increases with the level of the life annuity payment under the partial lump sum option is consistent with a strong underlying demand for liquid retirement assets. However, this interpretation does not change the fact that the forgone life annuity payments are quite valuable.

Overall, we find strong evidence that retirees respond rationally to measures that are easy to observe and interpret—such as poor health at the time of retirement, or higher life annuity payments under the partial lump sum option—but little evidence that they respond rationally to more sophisticated measures of annuity valuation. To the extent that our findings can be generalized to other retirees, a strong demand for liquid retirement assets, combined with a limited knowledge of how to accurately value life annuities, likely both contribute to the low demand for life annuities in the private market.

Appendix. Variation in PERS Life Annuities and Money's Worth

In this appendix, we describe the formulas used to calculate the level of the life annuity payments under the full life annuity and partial lump sum options. We also calculate the money's worth of the life annuities that retirees forgo by choosing the partial or full lump sum option. There are four inputs into the life annuity calculations. The first is a dummy variable, I_{PF}, which indicates whether the retiree is eligible for police and fire benefits, which are more generous than those available to normal members. The second is a dummy variable, I_{DCDB}, that indicates whether the retiree contributed into PERS before September 1981; if so, the retiree is eligible for full life annuity payments calculated under *DCDB*. The third input, x_{DB}, captures the defined benefit aspect of PERS retirement benefits, while the fourth input, x_{DC}, captures the defined contribution aspect of PERS retirement benefits. Formally,

$$x_{DB} = \text{Final Average Salary} \times \text{Years of Service} \times \text{Adjustment for Early Retirement}$$
$$x_{DC} = \text{Account Balance} \times AEF_{PERS}$$

where x_{DB} equals the retiree's final average salary times years of service times a factor that reduces benefits when retiring before the normal retirement age, and x_{DC} equals the retiree's PERS account balance times the actuarial equivalency factor that PERS uses to convert this account balance into a (baseline) life annuity payment. Note that AEF_{PERS} depends on age but not gender.

The level of the full life annuity payment is the maximum of three possible benefits:

$$A_{Default} = \max \begin{cases} x_{DC} \times 2 & (DC) \\ x_{DB} \times (0.0100 + 0.0035 \times I_{PF}) \times I_{DCDB} + \left(x_{DC} \times I_{DCDB}\right) & (DCDB) \\ x_{DB} \times (0.0167 + 0.0033 \times I_{PF}) & (DB) \end{cases}$$

When the retiree is eligible for the *DCDB* benefit, it equals 50.0% of the *DC* benefit plus 59.9% of the *DB* benefit for normal retirees (67.5% of the *DB* benefit for police and fire). For *DCDB*-

eligible retirees, as *DC* increases relative to *DB*, the maximal full life annuity transitions from *DB* to *DCDB* to *DC*. For *DCDB*-ineligible retirees, the maximal full life annuity transitions directly from *DB* to *DC*, but is lower for intermediate values of x_{DC} and x_{DB}. In contrast, the level of the life annuity payment associated with the partial lump sum option is calculated as the maximum of two possible benefits:

$$A_{PLS} = \max \begin{cases} x_{DC} \\ x_{DB} \times (0.0100 + 0.0035 \times I_{PF}) \end{cases}$$

neither of which depend on eligibility for the *DCDB* full life annuity benefit.

Because there are values of *DC* and *DB* for which *DCDB*-ineligible retirees receive lower full life annuity payments—but the same life annuity payments under the partial lump sum option—there values of x_{DC} and x_{DB} for which *DCDB*-ineligible retirees will find the partial (and full) lump sum option relatively more attractive. We summarize this information in Table A1. Specifically, we calculate three ratios related to the tradeoffs between the full life annuity, partial lump sum, and full lump sum options for four types of retirees. The top panel focuses on normal retirees, but distinguishes between those who are *DCDB*-eligible and *DCDB*-ineligible; the bottom panel is similar but focuses on police and fire. In each panel, the first row corresponds to situations in which the full life annuity payment is determined by *DB* regardless of I_{DCDB}. Similarly, the fourth row corresponds to situations in which the full life annuity payment is determined by *DC* regardless of I_{DCDB}. The second and third rows correspond to situations in which *DCDB*-eligible retirees receive higher full life annuity payments than otherwise similar *DCDB*-ineligible retirees.

The first ratio measures the reduction in life annuity payments associated with choosing the partial lump sum. It is defined as the incremental life annuity payment (i.e., the full life annuity payment minus the partial lump sum life annuity payment), divided by the full life

annuity payment. It ranges from 32.5% for police and fire retiring under *DB*, to 40.1% for normal retirees retiring under *DB*, to 50.0% for anyone retiring under *DC*. In situations where *DCDB*-ineligible retirees receive lower full life annuity payments than *DCDB*-eligible retirees., the reduction in life annuity payments from choosing the partial lump sum option is also lower.

The remaining ratios relate to the money's worth of the life annuity payments that retirees forgo by choosing a partial or full lump sum payout. The money's worth of paying P^k to receive initial life annuity payments of A^k, can be expressed as

$$MW^k = \left[\frac{A^k}{P^k} \times \frac{\$1{,}000}{AEF_{PERS}}\right] \times \frac{AEF_{PERS}}{\$1{,}000} \times EPV_g^k \equiv \delta^k \times \frac{AEF_{PERS}}{\$1{,}000} \times EPV_g^k$$

where δ^k measures money's worth relative to the money's worth of the full life annuity under *DC*. For example, when δ^k is greater than one, money's worth is higher than under *DC*. Note that when δ^k equals one, variation in money's worth is driven entirely by retiree age. This is because PERS rarely adjusts its actuarial equivalency factors, and because we estimate the expected present discount value of life annuity payments for each retiree using mortality tables from 2004.

Looking across the four types of retirees, three patterns emerge. First, when x_{DB} is "close" to x_{DC}, δ^k is higher for *DCDB*-eligible retirees than for *DCDB*-ineligible retirees. This pattern motivates us to test whether demand for lump sums is higher among this subset of *DCDB*-ineligible retirees. Second, aside from the row in which both *DCDB*-eligible and *DCDB*-ineligible retirees receive *DC*, the money's worth associated with the full lump sum option is higher than that associated with the partial lump sum option. This pattern suggests that when retirees are given the choice between partial and full lump sum payouts, the value of the forgone life annuity payments under the full lump sum option is (at least weakly) higher. Third, both patterns are more pronounced among the sample of police and fire retirees.

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Figure 1. Fraction of Oregon Public Employees choosing lump sum retirement benefits plotted with lagged stock returns, Jan 1990-Dec 2003
Time-series plot of the fraction of retirees in each month that choose either the partial lump sum or full lump sum option (scale on the left axis) and the return on the S&P 500 index over the prior 12 months (scale on the right axis).

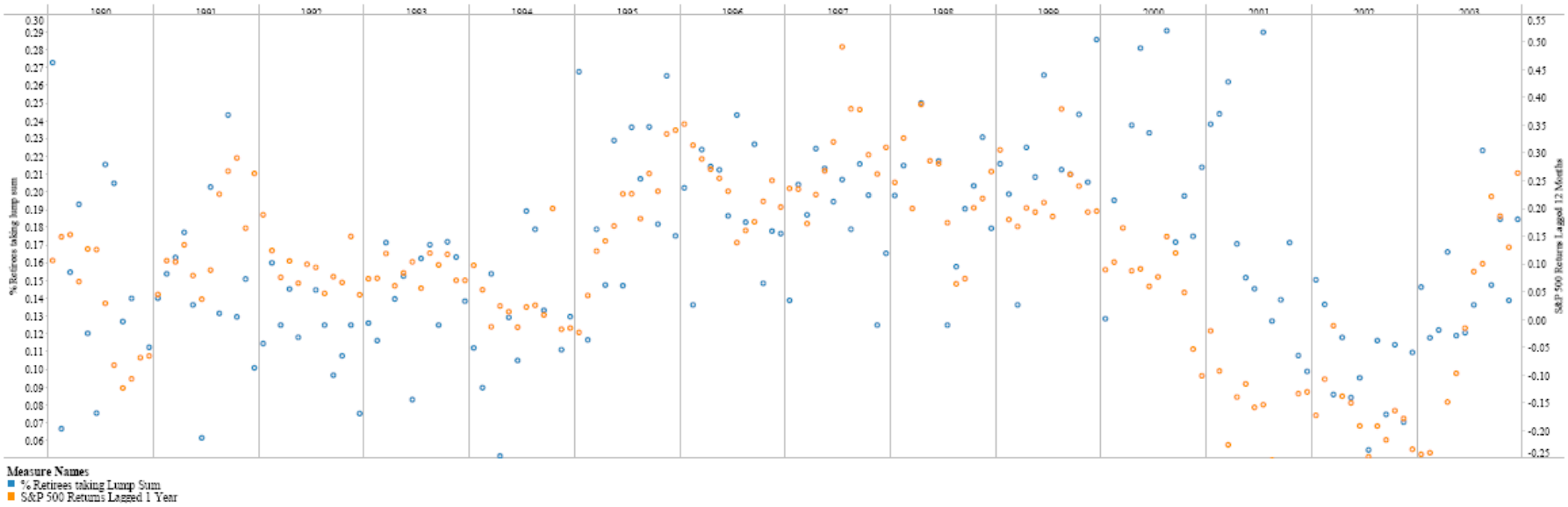

Table 1. Annual Retiree Characteristics from the Oregon Public Employees Retirement System

This table reports annual summary statistics for individuals retiring from the Oregon Public Employees Retirement System (PERS) between January 1990 and December 2003. The sample consists of retirees between the ages of 50 and 70, who begin collecting their PERS retirement benefits immediately after leaving employment. Panels A, B, and C focus on retirees whose full life annuity benefits are calculated under Money Match, Full Formula, and Formula plus Annuity, respectively. *Age* measures the member's age in the month of retirement; *Years of Service* measures the number of years during which the member contributed into PERS; *Monthly Salary* measures the member's average salary from PERS-covered employers over the prior 36 months; *Account Balance* measures the value of the member's contributions into the PERS retirement account at the time of retirement, which determines the size of the partial lump sum payout; % Female measures the fraction of retirees who are female; % Police or Fire measures the fraction of retirees who previously worked as police or fire officers; and *% Retiring Early* measures the fraction of members who retire before reaching the normal retirement age. *Full life annuity* is the level of the initial monthly life annuity payment under the full life annuity option, while *PLS Life Annuity* is the level of the initial monthly life annuity payment under the partial lump sum option. *Monthly Salary*, *Account Balance, Full Life Annuity*, and *PLS Life Annuity* are deflated using the Consumer Price Index (base period equals December 2003).

	# Retirees	Age	Year of Service	Monthly Salary	Account Balance	% Police & Fire	% Female	% Early Retiree	Full Life Annuity	PLS Life Annuity
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A. Retirees for Whom Full Life Annuity Payment Determined by DC										
1990	353	60.6	16.9	$4,397	$105,568	3.4%	37.1%	30.6%	$1,835	$918
1991	916	61.0	18.7	$4,201	$119,022	2.4%	40.7%	23.1%	$2,078	$1,040
1992	566	61.0	19.2	$4,327	$115,061	4.1%	36.6%	27.6%	$2,017	$1,010
1993	951	60.6	20.4	$4,418	$130,210	2.8%	37.4%	27.1%	$2,254	$1,129
1994	1,144	60.6	20.9	$4,453	$131,626	3.0%	42.0%	28.3%	$2,276	$1,141
1995	1,186	60.4	20.3	$4,140	$136,169	3.0%	49.7%	25.1%	$2,340	$1,172
1996	1,257	60.3	21.4	$4,219	$138,360	2.9%	47.4%	22.8%	$2,373	$1,191
1997	1,833	59.9	21.3	$4,269	$151,845	4.2%	53.2%	23.7%	$2,600	$1,304
1998	3,712	59.2	21.8	$4,402	$170,963	4.4%	53.6%	33.3%	$2,882	$1,444
1999	3,689	58.6	21.3	$4,464	$178,050	6.0%	54.8%	37.5%	$2,961	$1,484
2000	1,757	58.5	20.2	$4,372	$172,218	8.3%	55.4%	38.2%	$2,847	$1,428
2001	2,339	58.5	22.0	$4,561	$186,387	7.3%	55.5%	32.3%	$3,089	$1,549
2002	3,696	58.3	23.3	$4,771	$200,252	6.9%	54.4%	32.9%	$3,322	$1,667
2003	5,173	58.2	22.8	$4,623	$182,543	6.1%	57.4%	41.1%	$2,995	$1,505

Table 1 – (continued)

	# Retirees	Age	Year of Service	Monthly Salary	Account Balance	% Police & Fire	% Female	% Early Retiree	Full Life Annuity	PLS Life Annuity
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel B. Retirees for Whom Full Life Annuity Payment Determined by DB										
1990	388	59.6	18.8	$3,869	$58,381	13.9%	47.7%	5.4%	$1,453	$901
1991	261	59.9	14.9	$3,450	$41,045	14.2%	46.4%	11.1%	$1,101	$686
1992	357	60.4	14.8	$3,796	$45,689	15.4%	49.6%	9.8%	$1,156	$722
1993	394	61.5	12.1	$3,391	$31,275	14.7%	47.5%	8.1%	$849	$535
1994	639	60.8	13.8	$3,676	$41,310	12.8%	51.3%	8.5%	$1,048	$655
1995	270	61.2	9.7	$2,932	$20,876	7.4%	53.0%	11.9%	$488	$297
1996	398	61.1	10.8	$3,532	$30,847	11.8%	54.3%	6.5%	$738	$457
1997	315	60.5	11.4	$3,554	$33,183	14.3%	58.1%	14.0%	$753	$466
1998	262	60.3	11.6	$3,517	$32,667	14.9%	59.9%	18.3%	$772	$477
1999	228	60.4	11.5	$3,295	$29,623	18.9%	55.3%	15.8%	$689	$427
2000	147	60.4	9.5	$3,634	$28,598	17.0%	42.2%	19.0%	$648	$400
2001	277	60.6	10.3	$3,552	$31,814	11.9%	54.9%	18.4%	$728	$448
2002	454	60.7	10.2	$3,742	$31,323	14.8%	58.8%	19.6%	$717	$442
2003	793	60.4	11.3	$3,751	$35,954	12.4%	59.4%	23.6%	$776	$476
Panel C. Retirees for Whom Full Life Annuity Payment Determined by DCDB										
1990	1,033	60.6	19.9	$3,799	$75,782	6.0%	54.7%	13.3%	$1,464	$811
1991	831	59.4	21.8	$3,949	$92,857	13.8%	54.9%	9.4%	$1,741	$966
1992	1,078	59.8	22.2	$4,203	$95,623	13.3%	49.8%	12.2%	$1,826	$1,017
1993	978	59.5	22.6	$4,268	$102,043	13.9%	57.9%	10.6%	$1,919	$1,060
1994	1,578	58.9	23.5	$4,462	$109,979	15.5%	56.7%	11.1%	$2,062	$1,148
1995	315	58.5	21.1	$4,234	$102,272	23.2%	65.1%	9.8%	$1,854	$1,019
1996	538	57.9	22.9	$4,601	$120,100	24.5%	58.7%	8.7%	$2,182	$1,212
1997	428	56.5	23.4	$5,174	$148,158	45.6%	46.7%	11.0%	$2,683	$1,502
1998	340	55.8	23.8	$5,478	$173,030	59.1%	42.4%	17.4%	$3,022	$1,658
1999	271	55.5	24.4	$6,058	$204,577	65.7%	33.2%	11.8%	$3,519	$1,909
2000	88	54.7	24.4	$6,302	$223,413	72.7%	30.7%	8.0%	$3,818	$2,080
2001	136	55.0	24.8	$6,342	$218,772	62.5%	38.2%	11.0%	$3,709	$2,004
2002	224	55.6	25.0	$6,432	$222,378	61.2%	43.8%	14.3%	$3,814	$2,062
2003	347	55.3	25.2	$6,256	$221,179	66.0%	37.2%	11.5%	$3,759	$2,036

Table 2. Comparing Money's Worth of PERS and TIAA-CREF Life Annuities, 1990-2003

We compare the money's worth of life annuities based on the *DC* retirement benefit at PERS to the money's worth of life annuities available from TIAA-CREF. Our comparison assumes that the retiree is 65 years and 0 months old and male. The actuarial equivalency factor, AEF, determines the initial monthly life annuity payment per $1,000 spent to purchase the life annuity. Until July 2003, PERS does not adjust its AEFs. In contrast, TIAA-CREF adjusts its AEFs in January of each calendar year, to reflect changes in member life expectancies or (more significantly) the risk-free rate. EPV is the expected present value of receiving an initial monthly life annuity payment of $1.00, beginning next month. The nominal value of the life annuity payments to be received from PERS is assumed to grow at 2.0% per year, whereas the nominal value of life annuity payments to be received from TIAA-CREF is assumed not to grow. To calculate the probability that the retiree receives the life annuity payment *t* months from today, we use life tables published by the U.S. Social Security Administration for 2004. To calculate the present value of the expected payments, we use the yield on 10-year U.S. Treasury Notes at the end of the prior month (reported in the final column). Because PERS life annuity and lump sum payments are both taxed as ordinary income, we ignore taxes. We calculate money's worth of each life annuity as the expected present value of its life annuity payments relative to its price ((AEF * EPV) / $1000). In the second-to-last column, we calculate the money's worth of the PERS life annuity relative to the money's worth of the TIAA-CREF life annuity. Formally, θ equals (AEF_{PERS} * $EPV_{2\%}$) divided by (AEF_{TIAA} * $EPV_{0\%}$). When it equals one, PERS and TIAA-CREF allow retirees to purchase the same expected present value of life annuity benefits per dollar of initial outlay. Values greater than one, as observed through this table, imply that PERS sells more valuable life annuity benefits than TIAA-CREF at any given price. The bottom row reports the correlation between AEF, EPV or MW, and the yield on the 10-Year U.S. Treasury Note.

	PERS			**TIAA-CREF**			**PERS relative to TIAA-CREF**			**10-Year**
Year	AEF	EPV	MW	AEF	EPV	MW	AEF	EPV	MW	**Treasury**
	(1)	(2)	(3)	(4)	(5)	(6)	(7) = (1)/(4)	(8) = (2)/(5)	(9) = (3)/(6)	(10)
1990	9.79	115.94	1.14	8.82	99.39	0.88	1.11	1.17	1.30	8.4%
1991	9.79	119.51	1.17	8.75	102.19	0.89	1.12	1.17	1.31	8.0%
1992	9.79	126.22	1.24	8.52	107.41	0.92	1.15	1.18	1.35	7.3%
1993	9.79	135.81	1.33	7.72	114.84	0.89	1.27	1.18	1.50	6.4%
1994	9.79	145.37	1.42	7.10	122.20	0.87	1.38	1.19	1.64	5.6%
1995	9.79	123.27	1.21	7.72	105.12	0.81	1.27	1.17	1.49	7.6%
1996	9.79	145.37	1.42	7.10	122.20	0.87	1.38	1.19	1.64	5.6%
1997	9.79	134.68	1.32	7.34	113.97	0.84	1.33	1.18	1.58	6.5%
1998	9.79	146.64	1.44	7.03	123.18	0.87	1.39	1.19	1.66	5.5%
1999	9.79	157.50	1.54	6.61	131.47	0.87	1.48	1.20	1.77	4.7%
2000	9.79	132.48	1.30	7.39	112.27	0.83	1.33	1.18	1.56	6.7%
2001	9.79	150.57	1.47	7.08	126.18	0.89	1.38	1.19	1.65	5.2%
2002	9.79	153.28	1.50	6.77	128.25	0.87	1.45	1.20	1.73	5.0%
2003	9.79	168.08	1.65	6.16	139.51	0.86	1.59	1.20	1.92	4.0%
Correl.	*0.000*	*-0.996*	*-0.996*	*0.949*	*-0.997*	*0.016*	*-0.957*	*-0.999*	*-0.963*	*1.000*

Table 3. Percent of PERS Retirees Choosing Lump Sum Option, by Retirement Calculation Method, 1990-2003

This table summarizes the demand for lump sum options across years and across the three retirement benefit calculations: *DC, DB,* and *DCDB*. The sample is the same one that we summarized in Table 1. Between January 1990 and November 2002, *% Lump* reflects the fraction of retirees choosing the partial lump sum option (PLS). Between December 2002 and December 2003, *% Lump* reflects the fraction of retirees choosing either the partial lump sum option (PLS) or the full lump sum option (FLS). *MW FLA vs. PLS* is the money's worth of the full life annuity option relative to the partial lump sum option. It is defined as the expected present value of the incremental life annuity payments under the full life annuity option, relative to those under the partial lump sum option, divided by the partial lump sum payout. We report the median value of *MW FLA vs. PLS*.

	All Retirees			**DC**			**DB**			**DCDB**		
Year	# Retirees	% Lump	MW FLA vs. PLS	# Retirees	% Lump	MW FLA vs. PLS	# Retirees	% Lump	MW FLA vs. PLS	# Retirees	% Lump	MW FLA vs. PLS
1990	1,774	10.9%	$1.17	353	8.5%	$1.12	388	17.3%	$1.23	1,033	9.4%	$1.16
1991	2,008	10.8%	$1.21	916	9.2%	$1.20	261	25.7%	$1.24	831	7.8%	$1.21
1992	2,001	8.1%	$1.30	566	8.0%	$1.27	357	15.7%	$1.37	1,078	5.8%	$1.31
1993	2,323	11.5%	$1.47	951	10.0%	$1.42	394	24.9%	$1.50	978	7.7%	$1.52
1994	3,361	12.0%	$1.27	1,144	12.2%	$1.24	639	20.3%	$1.32	1,578	8.6%	$1.27
1995	1,771	17.5%	$1.39	1,186	17.3%	$1.39	270	25.9%	$1.31	315	11.1%	$1.47
1996	2,193	19.0%	$1.39	1,257	18.5%	$1.37	398	24.4%	$1.33	538	16.4%	$1.40
1997	2,576	18.9%	$1.42	1,833	19.4%	$1.43	315	25.7%	$1.30	428	11.7%	$1.45
1998	4,314	21.0%	$1.59	3,712	21.3%	$1.59	262	28.2%	$1.46	340	12.6%	$1.60
1999	4,188	21.0%	$1.51	3,689	20.8%	$1.51	228	25.9%	$1.35	271	18.8%	$1.51
2000	1,992	22.7%	$1.48	1,757	22.0%	$1.49	147	32.0%	$1.31	88	21.6%	$1.48
2001	2,752	16.2%	$1.63	2,339	15.7%	$1.63	277	20.6%	$1.55	136	15.4%	$1.64
2002	4,374	10.0%	$1.74	3,696	9.9%	$1.74	454	9.9%	$1.71	224	11.6%	$1.76
2003	6,313	13.3%	$1.90	5,173	12.9%	$1.90	793	15.6%	$1.85	347	13.8%	$1.94
Total	**41,940**	**15.3%**	**$1.50**	**28,572**	**15.9%**	**$1.55**	**5,183**	**20.7%**	**$1.42**	**8,185**	**10.0%**	**$1.34**

Table 4. Predicting Demand for Partial Lump Sum Payouts, Jan 1990-June 2002

We report marginal effects for logits. The dependent variable equals one when retiree k chooses the partial lump sum option and zero otherwise. Columns (1), (2), and (3) focus on the full sample of PERS retirees; column (4) is restricted to female retirees. *Ln MW of Full versus PLS* is the natural logarithm of the expected present value of the incremental life annuity payments under the full life annuity option divided by the partial lump sum payout. *Ln MW of PERS relative to MW of TIAA* is natural logarithm of the expected present value of life annuities payments under the PERS *Money Match* benefit per $1,000 of retirement account balance divided by the expected present value of life annuities payments from TIAA per $1,000 in initial outlay. All other variables are defined in section 4.1. Standard errors cluster on the year-month of retirement.

	(1)	(2)	(3)	(4)
Generosity of PERS Benefits				
Ln MW of Full versus PLS	0.022*	0.024*	0.032**	0.034**
	(0.011)	(0.013)	(0.012)	(0.017)
Ln MW of PERS relative to MW of TIAA		0.277***	0.282***	0.279***
		(0.058)	(0.057)	(0.060)
Lump Sum in Top 10% ($000, Dec 2003)			0.047***	0.020
			(0.012)	(0.010)
Incremental Life Annuity Payments in			0.066***	0.070***
Bottom 10% ($000, Dec 2003)			(0.010)	(0.011)
Retiree Not Eligible for *DCDB?*			-0.017*	-0.007
			(0.009)	(0.011)
Incremental Annuity Payment Lower Because			0.021**	0.009
Retiree Not Eligible for *DCDB?*			(0.008)	(0.010)
Level of PLS Life Annuity ($000, Dec 2003)	0.037***	0.043***	0.029***	0.044***
	(0.003)	(0.003)	(0.004)	(0.000)
Retiree Characteristics				
Dies within 48 months of retirement?	0.046***	0.047***	0.048***	0.078***
	(0.014)	(0.014)	(0.014)	(0.025)
Female?	-0.051***	-0.054***	-0.056***	
	(0.008)	(0.008)	(0.008)	
Positive allocation to variable account?	0.017***	0.020***	0.023***	0.022***
	(0.004)	(0.004)	(0.000)	(0.005)
Eligible for Police or Fire benefits?	-0.024***	-0.027***	-0.016**	0.026
	(0.006)	(0.006)	(0.007)	(0.018)
Chooses single life annuity?	0.082***	0.080***	0.080***	0.049***
	(0.000)	(0.004)	(0.004)	(0.005)
Estimated fraction of career spent working	-0.183***	-0.207***	-0.142***	-0.117***
for PERS employers	(0.021)	(0.023)	(0.019)	(0.023)
Salary at or above 75th percentile (within	-0.030***	-0.033***	-0.030***	-0.005
calendar year)?	(0.004)	(0.004)	(0.004)	(0.007)
Retiring before normal retirement age?	0.000	0.000	0.012	0.012
	(0.008)	(0.000)	(0.009)	(0.014)
Eligible for Tier 2 retirement benefits?	0.037	0.037	0.006	-0.021
	(0.034)	(0.030)	(0.029)	(0.040)
Market Returns				
Return on S&P 500 Index over prior 12 months	0.081**	0.156***	0.155***	0.140***
	(0.041)	(0.031)	(0.031)	(0.030)
Return in PERS retirement account over prior	0.029	-0.007	-0.002	0.071
12 months	(0.071)	(0.077)	(0.070)	(0.085)
Age-in-Years FEs?	Yes	Yes	Yes	Yes
Year FEs?	Yes	---	---	---
Sample Size	32,060	32,060	32,060	16,481
Pseudo R2	0.0523	0.0461	0.0508	0.0490

Table 5. Demand for Partial and Full Lump Sum Benefits, Jan 2002 – Dec 2003

This table summarizes monthly data on the choice of the partial lump sum and full lump sum options. It is based on the same sample of retirees described in Table 1. *MW Full vs. PLS* is the expected present value of the incremental life annuity payments under the full life annuity option (relative to those under the partial lump sum option) divided by the partial lump sum payout, which is the money's worth of the life annuity payments that are forgone by choosing the partial lump sum option. *MW Full vs. FLS* is the expected present value of the full life annuity payments divided by the full lump sum payout, which is the money's worth of the life annuity payments that are forgone by choosing the full lump sum option.

	# Retirees	% PLS	% FLS	MW Full vs. PLS	MW Full vs. FLS
Jan-02	223	15.2%		$1.61	
Feb-02	179	13.4%		$1.62	
Mar-02	152	9.2%		$1.53	
Apr-02	152	12.5%		$1.63	
May-02	188	9.0%		$1.61	
Jun-02	1,517	9.8%		$1.73	
Jul-02	120	5.8%		$1.68	
Aug-02	127	11.8%		$1.76	
Sep-02	161	8.1%		$1.92	
Oct-02	155	11.6%		$1.83	
Nov-02	406	7.1%		$1.83	
Jan-02 to Nov-02	**3,380**	**10.0%**	**0.0%**	**$1.72**	
Dec-02	868	6.9%	4.3%	$1.89	$1.94
Jan-03	473	6.8%	8.2%	$1.81	$1.89
Feb-03	516	6.0%	5.8%	$1.94	$1.99
Mar-03	387	7.5%	5.2%	$1.90	$1.96
Apr-03	311	11.3%	5.8%	$1.86	$1.92
May-03	2469	7.3%	4.7%	$2.00	$2.05
Jun-03	920	5.8%	7.2%	$1.98	$2.05
Jul-03	78	5.1%	10.3%	$1.61	$1.71
Aug-03	101	8.9%	13.9%	$1.68	$1.75
Sep-03	111	5.4%	10.8%	$1.76	$1.84
Oct-03	127	8.7%	10.2%	$1.71	$1.76
Nov-03	249	6.8%	7.2%	$1.68	$1.73
Dec-03	391	9.5%	9.5%	$1.66	$1.73
Dec-02 to Jun-03	**5,944**	**7.1%**	**5.5%**	**$1.93**	**$1.99**
Jul-03 to Dec-03	**1,057**	**7.9%**	**9.6%**	**$1.69**	**$1.74**
Dec-02 to Dec-03	**7,001**	**7.2%**	**6.1%**	**$1.90**	**$1.95**

Table 6. Predicting Demand for Partial and Full Lump Sum Payouts, Dec. 2002 – Dec 2003

We predict retirement payout choices during the period when PERS retirees have the added option to receive their retirement benefits as a full lump sum payout. In column (1), we report marginal effects from a standard logit where the dependent variable equals one if the retiree chooses the full lump sum option and zero if she chooses the partial lump sum option; the sample excludes retirees who choose the full life annuity option. In columns (2a) and (2b), we report marginal effects from a multinomial logit, which allows the impact of each independent variable to differ across the partial lump sum and full lump sum options. Money's worth measures are defined in section 4.2; all other variables are defined in section 4.1. Standard errors are clustered on the year-month of retirement.

Sample:	PLS=1 or FLS=1	All Retirees	
Estimation:	**Logit**	**Multinomial Logit**	
Predicting:	FLS = 1	PLS = 1	FLS = 1
	(1)	(2a)	(2b)
Generosity of PERS Benefits			
Ln MW of FLS vs. PLS	-0.252***		
	(0.084)		
Ln MW of FLA vs. PLS		0.029**	-0.044*
		(0.014)	(0.024)
Ln MW of FLA vs. FLS		0.067**	-0.027
minus Ln MW of FLA vs. PLS		(0.033)	(0.053)
Full life annuity Payment Lower	0.075	0.012	0.021
because not eligible for DCDB?	(0.047)	(0.010)	(0.017)
Retiree not eligible for DCDB?	-0.117***	0.013**	-0.008
	(0.042)	(0.005)	(0.006)
Post reduction in AEFs?	0.030	0.015*	0.017**
	(0.047)	(0.008)	(0.007)
Retiree Characteristics			
Female?	-0.018	-0.007	-0.010**
	(0.036)	(0.006)	(0.004)
Dies within 48 months?	0.210	-0.031**	0.002
	(0.222)	(0.015)	(0.024)
Positive Allocation to	0.015	0.019***	0.013**
Variable Account?	(0.033)	(0.005)	(0.006)
Eligible for Police or Fire benefits?	-0.094*	0.025***	0.004
	(0.052)	(0.007)	(0.015)
Estimated fraction of career spent	-0.709***	0.097***	-0.080***
working for PERS employers	(0.199)	(0.023)	(0.021)
Salary at or above 75th percentile	-0.119**	0.005	-0.019***
(within calendar year)?	(0.054)	(0.004)	(0.005)
Retiring before normal retirement age?	-0.094	0.010	0.000
	(0.067)	(0.007)	(0.011)
Eligible for Tier 2 retirement benefits?	0.426***	-0.033**	0.112***
	(0.073)	(0.016)	(0.024)
Age-in-Years FEs?	Yes	Yes	
Sample Size	925	7001	
R-Squared	0.1414	0.0472	

Table A1. Tradeoffs Between Full Life Annuity Option, Partial Lump Sum Option, and Full Lump Sum Option

This table summarizes the tradeoffs between the full life annuity, partial lump sum option, and full lump sum option for retirees for whom the full life annuity payments are calculated using different benefit formulas. I_{PF} is a dummy variable that indicates whether the retiree is eligible for police and fire benefits. Panel A focuses on normal retirees (I_{PF}=0) and Panel B focuses on police and fire (I_{PF}=1). I_{DCDB} is a dummy variable that indicates whether the retiree contributed into PERS before September 1981, making her eligible for *DCDB* full life annuity benefits. The four rows correspond to the different ways that full life annuities can be calculated for *DCDB*-eligible and *DCDB*-ineligible retirees, where *DC* is the defined contribution retirement benefit, *DB* is the defined benefit retirement benefit, and *DCDB* is half of the *DC* benefit plus more than half of the *DB* benefit. $\boldsymbol{x_{DB}}$ is defined as final average salary times years of service times a factor that reduces benefits when retiring before the normal retirement age. $\boldsymbol{x_{DC}}$ is defined as the PERS account balance times AEF_{PERS}. For normal retirees, the four rows correspond to (a) $\boldsymbol{x_{DC}} < 0.670\ \boldsymbol{x_{DB}}$, (b) $0.670\ \boldsymbol{x_{DB}} \leq \boldsymbol{x_{DC}} < 0.835\ \boldsymbol{x_{DB}}$, (c) $0.835\ \boldsymbol{x_{DB}} \leq \boldsymbol{x_{DC}} < \boldsymbol{x_{DB}}$, and (d) $\boldsymbol{x_{DC}} \geq \boldsymbol{x_{DB}}$. For police and fire, the four rows correspond to $\boldsymbol{x_{DC}} < 0.650\ \boldsymbol{x_{DB}}$, $0.650\ \boldsymbol{x_{DB}} \leq \boldsymbol{x_{DC}} < \boldsymbol{x_{DB}}$, $\boldsymbol{x_{DB}} \leq \boldsymbol{x_{DC}} < 1.350\ \boldsymbol{x_{DB}}$, and $\boldsymbol{x_{DC}} \geq 1.350\ \boldsymbol{x_{DB}}$. A_{Full} is the level of the life annuity payment associated with the full life annuity option and A_{PLS} is the level of the life annuity payment associated with the partial lump sum payout. $\boldsymbol{\delta_{PLS}}$ measures the money's worth of the forgone life annuity payments associated with choosing the partial lump sum option relative to case (d), when the full life annuity and partial lump sum life annuity are both calculated using *DC*. Similarly, $\boldsymbol{\delta_{FLS}}$ measures the money's worth of the forgone full life annuity payments associated with choosing the full lump sum option relative to case (d), when the full life annuity is calculated using *DC*. When $\boldsymbol{\delta_{PLS}}$ or $\boldsymbol{\delta_{FLS}}$ equals one, the only variation in money's worth comes from variation in AEF_{PERS}.

Panel A: Normal Retirees (I_{PF} = 0)

	Full Life Annuity Benefit		**$(A_{Full} - A_{PLS}) / A_{Full}$**		**δ_{PLS}**		**δ_{FLS}**	
	I_{DCDB} = 1	I_{DCDB} = 0	I_{DCDB} = 1	I_{DCDB} = 0	I_{DCDB} = 1	I_{DCDB} = 0	I_{DCDB} = 1	I_{DCDB} = 0
(a)	*DB*	*DB*	0.401	0.401	> 1	> 1	> 1.246	> 1.246
(b)	*DCDB*	*DB*	(0.401, 0.443)	0.401	1	[0.802, 1.000]	[1.099, 1.246]	[1.000, 1.246]
(c)	*DCDB*	*DC*	(0.443, 0.500)	(0.401, 0.500)	1	[0.802, 1.000]	[1.000, 1.099]	1
(d)	*DC*	*DC*	0.500	0.500	1	1	1	1

Panel B: Police and Fire Retirees (I_{PF} = 1)

	Full Life Annuity Benefit		**$(A_{Full} - A_{PLS}) / A_{Full}$**		**δ_{PLS}**		**δ_{FLS}**	
	I_{DCDB} = 1	I_{DCDB} = 0	I_{DCDB} = 1	I_{DCDB} = 0	I_{DCDB} = 1	I_{DCDB} = 0	I_{DCDB} = 1	I_{DCDB} = 0
(a)	*DB*	*DB*	0.325	0.325	> 1	> 1	> 1.538	> 1.538
(b)	*DCDB*	*DB*	(0.325, 0.426)	0.325	1	[0.650, 1.000]	[1.175, 1.538]	[1.000, 1.538]
(c)	*DCDB*	*DC*	(0.426, 0.500)	(0.325, 0.500)	1	[0.650, 1.000]	[1.000, 1.175]	1
(d)	*DC*	*DC*	0.500	0.500	1	1	1	1