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HOW DO RETIREES VALUE LIFE ANNUITIES? EVIDENCE FROM PUBLIC EMPLOYEES

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ABSTRACT

Economists have long been puzzled by the low demand for life annuities. To shed new light on this puzzle, we study payout choices in the Oregon Public Employees Retirement System, where each retiree must choose between a lump sum and a life annuity. Notably, the average life annuity we study is better than actuarially fair when compared to the lump sum and 85% of retirees choose the life annuity. Whether and how retirees respond to variation in the value of life annuity payments depends crucially on the source of variation. We find strong evidence that demand responds to variation in retiree characteristics. In contrast, we find little evidence that demand responds to plausibly exogenous variation in annuity pricing, which is economically meaningful but less salient. Finally, we find robust evidence that demand for the lump sum increases with recent equity market returns and other salient measures of investor sentiment.

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1. Introduction

Ever since Yaari's (1965) seminal paper, economists have argued that retirees should allocate a substantial portion of their assets to life annuities. Because life annuities continue making payments until death, they insure retirees against outliving their accumulated financial assets. In a standard life-cycle model, this insurance is quite valuable. It is puzzling, therefore, that the private market for life annuities is small.[1] The traditional explanation for this inconsistency between economic models and economic behavior is that adverse selection drives up annuity prices, which drives down demand. This presupposes that retirees are rationally comparing the price of a life annuity to the expected benefit of smoother lifetime consumption.[2] Alternatively, as delineated in Brown (2009) and Benartzi, Previtero, and Thaler (2011), the dearth of annuitization may reflect poor financial decision-making, resulting from financial illiteracy or behavioral biases. Distinguishing between rational and behavioral explanations for "under annuitization" is important because their welfare and policy implications are quite different.

Life-cycle models predict that demand for life annuities will be higher when the life annuity payments available to retirees are more valuable. Variation in the value of these payments can arise from differences in retiree characteristics or from differences in life annuity pricing. However, due to the lack of plausibly exogenous variation in life annuity pricing, the existing literature focuses on variation in retiree characteristics (e.g., Brown (2001), Finkelstein and Poterba (2004), Bütler and Teppa (2007), Previtero (2010), and Inkmann, Lopes, and Michaelides (2011)). While informative, these papers offer an incomplete picture of retiree be-

[1] According to Beacon Research, life annuity sales (outside of employer-sponsored retirement plans) were $8 billion in 2010, which is small relative to annual sales of other financial products, such as mutual funds.

[2] Even when 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 Mitchell, Poterba, Warshawsky, and Brown (1999), they are economically significant.

havior. The fact that demand for life annuities responds to variation in retiree health, for example, need not imply that it responds to variation in life annuity pricing, which may not be salient even when economically significant.

To offer a fuller picture of how retirees value life annuities, we study the actual payout decisions of retirees covered by the Oregon Public Employees Retirement System (PERS).[3] Our sample includes 32,060 retirements between January 1990 and June 2002. It has two notable features. First, each retiree must choose whether to receive higher life annuity payments and no lump sum payment (the "total life annuity" option) or lower life annuity payments and a lump sum payment (the "lump sum" option). The choice between additional life annuity payments and cash is analogous to the choice that retirees face in the private market. Second, our empirical setting provides us with a unique opportunity to study the impact of plausibly exogenous variation in life annuity pricing on retiree demand for life annuities.

Variation in life annuity pricing arises from the unusual way in which PERS calculates retirement benefits. Employees contribute a fixed percentage of their salary into an account with two investment options. Under the lump sum option, retirees are offered their accumulated retirement account balance as the lump sum payment. Under the total life annuity and lump sum options, life annuity payments are calculated using as many as three formulae, and retirees are automatically offered the maximum payments for which they are eligible. For some retirees, the maximum payment is based on the retiree's years of service and salary history. For other retirees, the maximum payment is obtained when the retirement account balance is multiplied by a conversion factor, referred to as the actuarial equivalency factor, which depends only on the retiree's age. While the conversion factors used in the private market offer retirees a risk-free rate

[3] PERS is the state agency that administers retirement plans for approximately 95% of the state and local public employees in Oregon. Our data exclude judges, politicians, or university employees. In 2009, PERS held nearly $53 billion in assets, making it the 21st largest public or private pension fund in the United States.

of return based on the yield on the 10-year U.S. Treasury Note, the conversion factors used by PERS offer retirees a risk-free rate of return of approximately 10 percent *regardless of current market conditions*.[4]

These features cause the pricing of PERS life annuities to deviate in three significant ways from the pricing of life annuities in the private market. First, PERS life annuity payments are significantly larger than those that could be purchased with the lump sum in the private market. This reflects that fact that the yield on the 10-year Treasury Note is below 10 percent during our entire sample period. For the median retiree, the total life annuity option has a "money's worth" of $1.45, meaning that the incremental life annuity payments have an expected present value of $1.45 per $1.00 in forgone lump sum payment. By way of comparison, Mitchell, Poterba, Warshawsky, and Brown (1999) show that the money's worth of life annuities offered by life insurance companies are between $0.80 and $0.90. Second, the fact that different retirees' maximum life annuity payments are calculated using different formulae generates cross-sectional variation in the value of PERS life annuity payments. Consider a retiree whose maximum life annuity payment is based on her years of service and salary. Because she is also eligible for life annuity payments offering a 10 percent rate of return, the payments based on her years of service and salary history must offer an even higher rate of return. This is one example of how retiree characteristics that would not impact the level of life annuity payments in the private market can impact the level of PERS life annuity payments. Another example is that retirees who first contributed into PERS after August 1981 are eligible to have their (maximum) total life annuity payments calculated using one fewer formulae than retirees who contributed into PERS before that date. Finally, because PERS conversion factors are not adjusted to reflect

[4] The PERS conversion factors are used to determine the initial life annuity payment. Because they were set well before our sample period begins, when interest rates were routinely near 8 percent, they assume that the risk-free rate of return is 8 percent. Because of the cost of living adjustment, payments then increase by 2 percent per year.

market conditions, time-series variation in the risk-free rate generates time-series variation in the value of the PERS life annuities relative to those in the private market. Everything else equal, the lower is the yield on the 10-year Treasury Note, the more valuable is the total life annuity option.

If retirees understand that PERS life annuities are better than actuarially fair, we should observe lower demand for lump sum payments in our setting than in other settings. Indeed, only 15% of PERS retirees choose the lump sum option. This fraction is significantly lower than one might surmise from a reading of the literature on the under-annuitization puzzle. It is all the more striking given that there is no default payout option, and that Oregon public employees are eligible to receive life annuity payments from Social Security.[5] One interpretation for our finding is that the average retiree recognizes that PERS life annuities are a "good deal." However, this begs the question of whether retirees respond to variation in the generosity of the life annuities available from PERS.

The fraction of retirees choosing the lump sum option ranges from 6.9% in 1992 to 21.7% in 2000. To explain variation in retiree choices we estimate both time-series regressions using the fraction of retirees choosing the lump sum option each month and logit regressions using individuals' choices. The logit regressions allow us to exploit the cross-sectional and time-series variation in the value of life annuity payments described above. They also allow us to control for differences in retiree characteristics, which we conjecture are the most salient source of variation. For example, not only should a life annuity be less valuable to a (single) retiree in poor health, but also the impact of poor health on the value of the life annuity should be easily

[5] Because Madrian and Shea (2001) show that default options can have a dramatic impact on financial choices, it is fortuitous that PERS retirees are not assigned to either payout option by default. Retirees must actively choose. We should only observe a retiree choosing the total life annuity option when the value she attaches to the incremental life annuity payments exceeds the value she attaches to the lump sum payment.

understood. Indeed, we find strong evidence that retirees understand how differences in health, risk aversion, and the level of already-annuitized income impact the value of the incremental life annuity income. These findings are consistent with the predictions of life-cycle models, and with Brown (2001), Finkelstein and Poterba (2004), and Inkmann, Lopes, and Michaelides (2011).

In contrast, when we focus on plausibly exogenous variation in life annuity pricing, our findings are difficult to reconcile with the predictions of life-cycle models. Although we observe significant cross-sectional variation in the value of life annuity payments due to the use of multiple benefit formulae, the evidence that retirees respond to this variation is weak. This suggests that cross-sectional variation in annuity pricing is not salient. And, although demand for the lump sum option should decrease when the gap between the life annuity payments available from PERS and insurance companies like TIAA increases, we find the opposite. One explanation for this puzzling relation is that retirees are confused about the role that interest rates play in life annuity valuation, which is consistent with the evidence in, for example, Campbell (2006) and Lusardi and Mitchell (2007) that financial illiteracy leads to financial mistakes.

An alternative explanation is that falling interest rates are correlated with declining economic conditions, which increase the relative value of the lump sum payment. Similarly, because our sample period includes the NASDAQ bubble, changes in interest rates may be correlated with changes in investor sentiment. To address concerns about potential omitted variables bias we include proxies for economic conditions and investor sentiment that include the return on the S&P 500 index over the prior 12 months, the inflation-adjusted level of the NASDAQ index, and the level of the CBOE Volatility Index (VIX). While including these controls reduces the size of the puzzling relation, we still do not find any evidence that lower interest rates decrease demand for the lump sum option. Instead, we find robust evidence that demand for the lump

sum option is higher when equity market returns are higher, even after directly controlling for returns posted to retirees' PERS retirement accounts. Although we do not observe if retirees invest the lump sum payment in risky assets, this finding is consistent with retirees using the lump sum to naively chase past returns.[6]

Because the life annuities available from PERS offer a risk-free rate of return of at least 10 percent, retirees who overvalue the lump sum option are likely to be making a costly and irreversible mistake. To put the economic magnitude of this mistake in context, consider the 453 retirees who choose the lump sum option in 2000. The average retiree trades life annuity payments with an expected present value of $225,421 for a lump sum of $151,367, suggesting an average loss of $74,054.[7]

In Section 2, we discuss the existing empirical literature. In Section 3, we motivate our empirical predictions and discuss identification. In Section 4, we describe our data. In Section 5, we study how demand for lump sum payments varies with retiree characteristics, the relative value of the incremental life annuity payments, and recent equity market returns. In Section 6, we conclude. The Appendix provides a detailed description of the PERS benefit calculations.

2. Related Empirical Literature

Our findings complement existing studies of the choice between incremental life annuities and lump sums. Finkelstein and Poterba (2004) find evidence of adverse selection using data on life annuities purchased from a large U.K. annuity company. Similarly, we find that *ex post* mortality is associated with lower demand for incremental life annuities, especially among retir-

[6] Benartzi (2001) provides evidence that employees allocate more of their 401(k) contributions to company stock when the company's stock return over the prior decade is higher. Similarly, Chevalier and Ellison (1997) and Sirri and Tufano (1998) provide evidence of return chasing behavior by mutual fund investors. However, Berk and Green (2004) argue that return chasing is not necessarily irrational when choosing mutual funds.

[7] This calculation ignores the fact that retirees with shorter-than-average life expectancy are more likely to choose the lump sum option, but it also ignores the insurance value that risk-averse retirees derive from life annuities.

ees who are more likely to be single. Inkmann, Lopes, and Michaelides (2011) use cross-sectional data from the 2002-2003 English Longitudinal Study of Ageing to study household demand for voluntary life annuities. They find that demand responds to differences in life expectancy, the level of already-annuitized income, and other household characteristics. Then, they argue that a life-cycle model that incorporates demand for life annuities, life insurance, savings, and portfolio choice can rationalize the fact that only 5.9% of the households in their sample purchase incremental life annuities. Interestingly, although PERS retirees' characteristics have a qualitatively similar impact on demand for incremental life annuities, we find that 85% of the retirees in our sample choose incremental life annuities.

Bütler and Teppa (2007) study payout choices for ten Swiss pension funds. Consistent with our findings, they find that the majority of retirees choose life annuities over lump sums. Therefore, the low demand for life annuities in the private market may reflect the fact that retirees have access to sufficient life annuity income through their pensions, or it may signal that the search costs associated with shopping for a life annuity are high. Previtero (2010) studies the choice between life annuity and lump sum payments by private employees using data from defined benefit plans. Consistent with our findings, he finds that demand for life annuities is negatively correlated with recent stock market returns. However, because the money's worth of the life annuities in his setting match those available in the private market, the welfare cost of return chasing is lower than in our setting, where life annuities are better than actuarially fair.

3. Empirical Predictions

In a standard life-cycle model, life annuities increase expected utility by making the individual's consumption between retirement and death both higher and less uncertain.[8] In our set-

[8] Yaari (1965) derives conditions under which a retiree with an unknown date of death should convert all of her liquid retirement assets into life annuities. Davidoff, Brown, and Diamond (2005) extend this analysis by showing that

ting, incremental life annuity payments increase expected utility by increasing the level of risk-free income, and therefore potential consumption, during retirement. The lump sum option, on the other hand, trades incremental life annuity payments for a cash payment, which can be invested in risky liquid assets, invested in safe liquid assets, or used to purchase goods and services.[9] Therefore, the choice between the total life annuity and lump sum options should depend on the expected present value of incremental life annuity payments relative to the level of the lump sum payment, plus any option value associated with holding liquid assets. We use his tradeoff to motivate our empirical predictions.

Note that because the vast majority of PERS incremental life annuities are better than actuarially fair, an implicit assumption throughout our paper is that market frictions limit the ability of retirees to convert life annuities into lump sums in the private market. A natural and likely source of friction is asymmetric information about retiree life expectancy. In the absence of these frictions, all retirees with a normal life expectancy should choose the total life annuity option, and those who prefer a lump sum should convert some portion of their life annuity payments into a (larger) lump sum.

3.1. Variation in Retiree Characteristics

Our first set of predictions are based on the fact that differences in retiree characteristics can generate cross-sectional differences in the expected utility associated with life annuity payments. Because Brown (2001), Finkelstein and Poterba (2004), Bütler and Teppa (2007), and Inkmann, Lopes, and Michaelides (2011) find support for related predictions, we are primarily

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retirees would benefit from converting a significant fraction of their assets into life annuities under much less restriction conditions. Life annuities in the private market are able to offer higher rates of return than other risk-free investments because they transfer assets from those who die to those who survive.

[9] Bequest motives typically reduce demand for life annuities. However, because the incremental life annuities that we study are better-than-actuarially fair, PERS retirees with bequest motives should choose the total life annuity option and use the monthly payments to purchase life insurance.

interested in exploring whether PERS retirees behave like the retirees studied in other settings.

We consider seven retiree characteristics. First, because PERS does not adjust life annuity payments for differences in retiree health, we predict that the lump sum option will be more valuable to single retirees in poor health, who should expect to receive fewer payments. Second, because PERS does not adjust life annuity payments for the different life expectancies of males and females, we predict that the lump sum option will be more valuable to single male retirees, who should expect to receive fewer payments than single female retirees. Third, like other forms of insurance, life annuities should be less valuable to a retiree who is less risk averse. We predict that a retiree who allocates more of her retirement account allocations to the riskier of the two investment options will be more likely to choose the lump sum option. Fourth, to the extent that police and fire officers' greater tolerance for occupational risk translates into greater tolerance for financial risk, police and fire officers will be more likely to choose the lump sum option. Fifth, because the marginal value of insurance declines with the level of insurance, the value that a retiree attaches to the incremental life annuity should fall with the level of already-annuitized income. We predict that demand for the lump sum option will rise with the level of the life annuity payments under the lump sum option. Sixth, we predict a retiree who is more reliant on PERS retirement benefits because she spent a larger fraction of her career working for PERS employers is less likely to choose the lump sum option. Seventh, to the extent that financial literacy is positively correlated with income (Campbell (2006)), we predict that a retiree with a higher pre-retirement salary will be less likely to choose the lump sum payment over a better than actuarially fair life annuity.

Note that because all retirees receive some life annuity payments, retirees must also choose between single life annuities, which stop making payments when the retiree dies, and

joint life annuities, which stop making payments only after the retiree and their beneficiary have died. Because joint life annuities are more likely to be chosen by married retirees, who must also consider the financial needs of their spouses, we expect the characteristics of retirees choosing joint life annuities to explain less variation in demand for lump sums (which is what Brown (2001) finds.) Finally, Brown and Poterba (2000) argue that access to joint life annuities should make married retirees less likely to fully annuitize their retirement assets than single retirees. The complication with testing this prediction in our setting is that, although we lack the data needed to systematically compare the money's worth of single and joint life annuities, calculations based on the actual payout options of a married retiree suggest that joint life annuities are significantly more generous than single life annuities.

3.2. Cross-Sectional Variation in Life Annuity Pricing

Our second set of predictions focus on plausibly exogenous cross-sectional variation in life annuity pricing arising from how PERS calculates retirement benefits. To understand how we exploit this variation, it is necessary to provide additional details on how retirement benefits are determined under the total life annuity and lump sum options. PERS employees contribute 6% of their salary to a defined contribution-style retirement account with two investment options. They have the option to invest 25%, 50% or 75% of their contribution to the riskier "variable" account; the remainder is invested in the safer "regular" account. The contributions and returns posted to these two accounts determine the accumulated account balance at retirement, which is the size of the lump sum payment under the lump sum option.

The level of the life annuity payment under the total life annuity option is automatically calculated as the maximum of three possible benefit formulae. *DC* is a traditional defined contribution retirement benefit that depends on the actuarial equivalency factor that PERS uses to

annuitize the retirement account balance. *DB* is a traditional defined benefit retirement benefit that depends on years of service, salary history, whether the retiree is a police or fire officer, and an adjustment for early retirement. *DCDB* is a hybrid benefit that equals half of *DC* plus slightly more than half of *DB*, but that is only available to employees who first contributed into PERS on or before August 1981.[10] The level of the life annuity payments under the lump sum option is automatically calculated as the maximum of two benefits: half of the total life annuity payment under *DC* or slightly more than half of the total life annuity payment under *DB*. Eligibility for *DCDB* only impacts the level of the life annuity payments under the total life annuity option.

When comparing the total life annuity option to the lump sum option, life-cycle models predict that retires will compare the expected present value of the incremental life annuity payments under the total life annuity option to the lump sum payment they must forgo. Dividing the incremental life annuity payment by the lump sum payment yields an annuity price that is analogous to the actuarial equivalency factor quoted in the private market. The fact that PERS uses multiple formulae to calculate life annuity payments under the total life annuity and lump sum options generates cross-sectional variation in this annuity price. Depending on the combination of formulas used to calculate the maximum life annuity payments, the dollar value of the incremental life annuity payments can range from 32.5% to 50% of the total life annuity payment. If this variation in annuity pricing is salient to retirees, we predict that demand for the lump sum option will be lower when the relative value of the incremental life annuity payments is higher.

Because the total life annuity payments of retirees who first contributed into PERS after August 1981 are calculated using two formulae instead of three, there are circumstances under which these retirees are eligible for smaller incremental life annuity payments than retirees who

[10] PERS refers to the *DC, DB,* and *DCDB* options as "Money Match", "Full Formula", and "Formula plus Annuity". We state the various total life annuity and partial life annuity formulas in the Appendix.

first contributed into PERS on or before August 1981 (holding retiree characteristics and the retirement account balance constant). If this particular source of cross-sectional variation is salient, we predict that it will increase demand for the lump sum option.

While variation due to the choice of retirement benefit formulas would normally raise concerns about strategic behavior, PERS retirees automatically receive the maximum life annuity payments for which they are eligible. While retirees can expect to increase their future retirement benefits by working another year, or by allocating a larger fraction of their retirement contributions to the risky investment, they have no influence over which formulas PERS uses to calculate their life annuity payments under the total life annuity and lump sum options, and hence no influence over the level of the incremental life annuity payments.

3.3. Time-Series Variation in Life Annuity Pricing

The final prediction concerns variation in PERS life annuity pricing due to time-series variation in the risk-free rate. In the market for private life annuities, insurance companies use the prevailing risk-free rate to set the actuarial equivalency factor, which determines the level of life annuity payment per dollar invested. When interest rates fall, the actuarial equivalency factors available from TIAA and other insurance companies fall. In contrast, the actuarial equivalency factors that PERS uses in its retirement benefit calculations rarely change. Because of this inertia, when the risk-free rate falls, life annuity payments available from PERS become relatively more generous than the life annuity payments available from TIAA. To be clear, lower interest rates do not change the dollar value of the PERS incremental life annuity payments. Instead, they increase the cost of buying the same incremental life annuity payments in the private market. Or, put differently, they increase the gap between the rate of return that retirees can earn on their retirement account balance by choosing the total life annuity option and the risk-free rate of

return available in the market. For this reason, we predict that demand for the lump sum option will be lower when interest rates are lower.

There are several caveats. The prediction that lower interest rates make life annuities more valuable is unique to our setting. Milevsky and Young (2002) argue that retirees in the private market should delay annuitization when interest rates are low, rather than lock in permanently low life annuity payments.[11] The facts that PERS life annuity payments become relatively more valuable when the risk-free rate falls, and that they are only available at the time of retirement, imply that PERS retirees are unlikely to benefit from delaying annuitization.

More importantly, our prediction holds the value of the lump sum payment constant. To identify retirees' choices as mistakes, we must rule out the possibility that lower interest rates rationally increase demand for risky liquid assets, safe liquid assets, or consumption. Although we are limited by the fact that we do not observe whether the lump sum is invested or consumed, we are able to explicitly test two alternatives. The first is that lower interest rates increase the value of already-annuitized income, and that the resulting income effect increases demand for the lump sum option. The second is that lower interest rates proxy for greater economic uncertainty, which increases the value of the lump sum option by even more than it increases the value of the incremental life annuity payments. To control for variation in economic uncertainty, we control for the level of the CBEO Volatility Index (VIX) at the end of the month before the payout choice.[12] If larger values of VIX, which is also known as the "fear index", increase demand for liquid savings, the coefficient on the control variable will be positive.[13]

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[11] Also see Tergesen, Anne, and Leslie Scism, "Are Annuities Being Overhyped as a Retirement Cure-All?", *Wall Street Journal*, February 13, 2010.

[12] VIX measures the expected volatility on U.S. equity over the next 30 days. It has been shown to be negatively correlated with mutual fund flows and other measures of investor sentiment. See, for example, Ben-Rephael, Kandel, and Wohl (2010).

[13] On the other hand, Sundaresan (2001, p. 208) provides evidence that interest rate volatility is positively correlated with the level of interest rates. Given the 2% annual cap on cost of living adjustments it seems just as likely that

Finally, demand for the lump sum option may respond, for rational or behavioral reasons, to time-series variation in investor sentiment. If fluctuations in interest rates and investor sentiment are correlated, and we do not control for fluctuations in investor sentiment, the coefficient on our measure of relative generosity will suffer from omitted variables bias. To distinguish the impact of interest rates from the impact of the NASDAQ bubble, which burst toward the end of our sample period, we control for the inflation-adjusted level of the NASDAQ index, which has a correlation of 0.4638 with our measure of PERS generosity. We also control for the return on the S&P 500 index over the prior 12 months. To the extent that retirees forgo better than actuarially fair life annuity payments in response to recent equity market conditions, they may be making costly mistakes.

3.4. Measuring Variation in Life Annuity Pricing

As introduced earlier, the money's worth of the incremental life annuity is the expected present value of the future life annuity payments, per dollar of initial outlay. The money's worth of the incremental life annuity payments available to retiree k is defined as:

$$MW_{Max}^{k} = \left[A^{k} \right] \times \left[\frac{1}{P^{k}} \right] \times EPV_{g}^{k} \qquad (1)$$

where A^k is the initial level of the incremental life annuity payment to retiree k, P^k is the level of the forgone lump sum payment (i.e., the price of the incremental life annuity payments), 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, which depends on the probability that retiree k is alive to receive each payment.[14] When incremental life annuity payments are priced to be actuarially fair, money's

higher interest rate volatility could generate more demand for lump sum payments, which could be invested in assets offering even better inflationary hedges. This argument suggests that lower interest rates should decrease demand for the lump sum option.

[14] When estimating the expected present 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

worth equals $1.00.

Life annuity payments are quoted in terms of actuarial equivalency factors, which state the (fixed, nominal) number of dollars paid out each month until death, per $1,000 in initial outlay. When the maximal total life annuity and partial life annuity payments for retiree *k* are both calculated under *DC*, the money's worth of the incremental life annuity payments is

$$MW_{DC}^{k} = \left[\frac{AEF_{PERS}^{k} \times \text{Account Balance}}{\$1{,}000} \right] \times \left[\frac{1}{\text{Account Balance}} \right] \times EPV_{g}^{k} \qquad (2)$$

where AEF_{PERS} increases with retiree age, to reflect declining life expectancies, but does not vary with gender.[15] Because PERS life annuities include a cost of living adjustment that is capped at 2.0% per year, and because that cap is binding throughout our sample period, we set *g* equal to 0.17% per month. To distinguish between the cross-sectional and time-series variation that we described in sections 3.2 and 3.3, we rewrite the money's worth of the incremental life annuity payments as the product of three terms:

$$MW_{Max}^{k} = \left[MW_{TIAA}^{k} \right] \times \left[\frac{MW_{Max}^{k}}{MW_{DC}^{k}} \right] \times \left[\frac{MW_{DC}^{k}}{MW_{TIAA}^{k}} \right] = \left[MW_{TIAA}^{k} \right] \times \left[\delta^{k} \right] \times \left[\theta^{k} \right] \qquad (3)$$

The first term is the money's worth of the life annuity that retiree *k* could purchase from TIAA with the lump sum payment, our proxy for how life annuities are priced in the private market. The second term, δ, captures cross-sectional variation arising when the maximum life annuity payments under the total life annuity and lump sum options are not both calculated using the *DC* benefit formulas. For example, δ captures cross-sectional differences in the money's worth of retirees' incremental annuity benefits based on whether they are ineligible for the DCDB total

Security Administration for 2004. The second assumption leads us to slightly overestimate the estimated present value in 1990 relative to 2002.

[15] 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, among others.

life annuity benefit because they first contributed into PERS after August 1981. The third term, θ, captures time-series variation in the value of PERS life annuities relative to those available from TIAA, which is driven by changes in the risk-free rate.

4. Data

Between January 1990 and June 2002, we observe the payout choices of 32,060 retirees between the ages of 50 and 70. For each retiree, we observe whether she chooses the total life annuity option or the lump sum option. We also observe her retirement account balance, her allocation between the regular and variable account prior to retirement, her choice between a single and joint life annuity, and the other demographic characteristics required to calculate her life annuity payments under the different benefit formulae for which she is eligible.

In Table 1, we provide separate summary statistics for retirees whose total life annuity benefits are calculated using *DC* (66.4% of retirees), *DB* (9.8%), and *DCDB* (23.8%). Columns (2) through (8) summarize inputs into the various life annuity benefit formulas, and columns (9) and (10) report the (initial) monthly life annuity payments under the total life annuity and lump sum options. *Monthly Salary* (4), PERS retirement *Account Balance* (5), *Total Life Annuity* (9), *Partial Life Annuity* (10), and *Incremental Life Annuity* (11) 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 in the panels of Table 1. For example, life annuity payments calculated under *DC* are increasing in the level of the PERS retirement account balance, while payments calculated under *DB* are not. Consequently, the average *Account Balance* ranges from $110,538 to $197,325 under *DC*, but from $27,484 to $73,329 under *DB*.

Table 1 highlights the variation in annuity pricing faced by retirees whose maximal total life annuity payments are calculated under *DC, DB,* and *DCDB*. Consider retirees in 1995. In Panel A, the average retiree forgoes approximately 50% of the total life annuity monthly payment of $2,434 to receive an immediate lump sum payment of $141,662. On the other hand, in Panel B, the retiree forgoes approximately 40% of the total life annuity monthly payment of $643 to receive an immediate lump sum payment of $27,484.

In Table 2, we illustrate how the relative value of PERS life annuity payments varies with the risk-free rate of return. Specifically, we calculate the money's worth of PERS incremental life annuity payments under *DC* for male retirees who turn 65 in January 1990, January 1991, …, January 2002. We also calculate the money's worth of the life annuity payments that retirees could purchase from TIAA using the lump sum payment. For these retirees, the PERS life annuity is always better than actuarially fair, with money's worth ranging from $1.14 in January 1990 to $1.50 in January 2002.

Within our sample of 32,060 retirees, the money's worth of the incremental life annuity is better than actuarially fair for all but 112 retirees. In contrast, the money's worth of the life annuities offered by TIAA is less volatile, and never more than $0.92. For a 65-year old male in Table 2, θ ranges from 1.30 to 1.77. Within our full sample of retirees, θ ranges from 1.17 to 1.82, with an average value of 1.60. The main source of time-series variation in θ is the fact that TIAA adjusts its actuarial equivalency factors each January, based on changes in annuitant life expectancy and the risk-free rate, whereas PERS does not.[16] In the bottom row of Table 2, we show that the correlation between the yield on 10-Year U.S. Treasury Notes and TIAA's actuari-

[16] PERS adjusts its actuarial equivalency factor tables once during our sample period. On January 1, 1997, PERS switches from actuarial equivalency factors that increase annually, in the retiree's birth month, to factors that increase monthly. At the same time, PERS increases actuarial equivalency factors for those retiring below the age of 55. However, the increases are small, ranging from 2.2% at age 50 to 0.1% at age 54.

al equivalency factors (column (4)) is 0.935. We also show that the correlation between the Treasury yield and θ (column (9)) is -0.955.

5. How Do PERS Retirees Value Incremental Life Annuities?

Table 3 reports the fraction of PERS retirees choosing the lump sum option each year. Notably, only 15% choose the lump sum option; the other 85% choose to receive all of their retirement benefits in the form of life annuity payments. The high demand for incremental life annuities in our setting is striking, and is consistent with the fact that PERS incremental life annuities have much higher money's worth than life annuities available in the private market.

The low demand for lump sum payments is also consistent with alternative explanations. It may reflect the fact that individuals with greater demand for annuitized retirement benefits are more likely to become public employees. It may reflect the fact that it is easier for employees to choose the total life annuity payout option over the lump sum option than it is for other retirees to research and purchase incremental life annuities in the private market. Or, because PERS reports the monthly payment associated with each payout option rather than the implied rate of return, it may reflect the framing effect described in Brown, Kling, Mullainathan, and Wrobel (2008). We cannot measure the impact of these explanations on the average demand for lump sum payments. However, because they are time-invariant, they are unlikely to explain time-series variation in the fraction of retirees choosing the lump sum option.

5.1. Time-Series Regressions

Figure 1 reveals significant time-series variation in the fraction of retirees choosing the lump sum option, and Table 3 shows that this variation exists regardless of how the total life annuity benefit is calculated. In Table 4, we seek to explain this time-series variation in demand for the lump sum option. The dependent variable in each time-series regression is the fraction of

retirees that choose the lump sum option in month *t*. Because the number of retirements varies significantly across months (from a low of 6 in January 1990 to a high of 2,999 in February 1998), this fraction is a noisier estimate of retiree preferences in some months than others. To account for this heteroskedasticity, we weight each observation by the number of retirements in that month. Standard errors are estimated using the Newey and West (1987) estimator, allowing autocorrelation to persist for 24 months.

Our basic prediction is that demand for the lump sum option will fall when incremental life annuities are more valuable. Yet, in column (1), we find that demand for the lump sum option rises when PERS life annuities are relatively more generous than those available from TIAA. The coefficient is statistically significant at the 1-percent level. It is also economically significant. A one-standard deviation increase in the relative generosity of PERS is associated with a 3.2 percentage point increase in the demand for the lump sum option. In other words, demand for lump sums is increasing precisely when the relative value of the incremental life annuities available from PERS is increasing. One interpretation is that retirees are confused about the impact of interest rates on the value of PERS life annuity payments. For example, they may be following advice like that in Milevsky and Young (2002) to delay annuitization when the risk-free rate is low—despite the fact that this advice does not apply in our setting. However, as we discuss in Section 3.3, it is important to control for variation in economic conditions and investor sentiment that may lead retirees to prefer a lump sum despite the lower interest rates.

We learn three things when we control for the return on the S&P 500 index over the prior 12 months, the level of VIX in the prior month, and the inflation-adjusted level of NASDAQ in the prior month. First, the coefficient on our measure of PERS generosity falls by approximately 60% between column (1) and column (4), highlighting the need to control for variation in eco-

nomic conditions and investor sentiment. Second, the coefficient nevertheless remains positive and statistically significant at the 1-percent level in columns (2) through (4), and at the 10-percent level when we switch from levels to first differences in column (5). It also remains positive and statistically significant at the 1-percent level in an unreported regression that ends the sample in December 1998, to exclude the NASDAQ crash. In other words, regardless of how we control for economic conditions and investor sentiment, we find no evidence that retirees understand that lower interest rates increase the value of PERS life annuity payments.[17]

The third insight is that economic conditions and investor sentiment help to explain demand for the lump sum option. We find some evidence that demand for the lump sum option is increasing in both the level of VIX and the inflation-adjusted level of NASDAQ in the month immediately before the payout choice. However, the estimated coefficient on VIX is not statistically significant when we control for the level of NASDAQ. Our most robust finding is that demand for the lump sum option rises with recent equity market returns (p-value of 0.001). In terms of economic significance, a one-standard deviation increase in the lagged return on the S&P 500 index is associated with a 2.2 to 2.6 percentage point increase in the demand for the lump sum option. The most provocative interpretation of this correlation is that retirees are extrapolating future equity market returns from recent equity market returns, and then using the lump sum payment to chase recent equity market returns.[18]

5.2. Predicting Individual Demand for the Lump Sum Option

We now turn our attention to individual-level retirement payout choices. In Table 5, we

[17] In an unreported specification, we include the fraction of retirees who chose the lump sum payment in the previous month, as a control for the impact of economic conditions and investor sentiment in the prior month, as well as the P/E ratio on the S&P 500 index in the prior quarter. The coefficient on our measure of PERS generosity increases from 0.111, in column (4), to 0.137, and remains statistically significant from zero at the 1-percent level.

[18] The return chasing interpretation is consistent with behavior that Chevalier and Ellison (1997) and Sirri and Tufano (1998) observe in the mutual fund industry, and that Benartzi (2001) observes when studying how investors allocate 401(k) plan assets to company stock.

report marginal effects from five logit models where the dependent variable equals one if retiree *k* chooses the lump sum option, and zero if she chooses the total life annuity option. We use three sets of independent variables to explain the individual payout choices of 31,809 retirees.[19] The first set measures differences in retiree characteristics, including differences in life expectancy, risk aversion, and the level of life annuity income under the lump sum option. The second set measures variation in the money's worth of the incremental life annuity payments, which distills our cross-sectional and time-series variation into a single measure of annuity pricing. (In Table 6, we distinguish between different sources of variation in money's worth.) The third set controls for economic conditions and investor sentiment. It includes the lagged return on the S&P 500 index, the lagged return earned in the retiree's PERS retirement account, the inflation-adjusted level of NASDAQ measured at the end of the previous month, the level of VIX at the end of the previous month, and the local (county-level) unemployment rate.

Each specification includes a separate fixed effect for each year of service (1, 2, 3, …) to control for variation in payout choices that is related to length of service within PERS. Columns (2) through (5) also include a separate fixed effect for each year of age (50, 51, 52, …) to control for variation in payout choices that is related to age at retirement.[20] Because retirees choosing joint life annuities are more likely to be married, their payout choices should depend on the characteristics of the retirees, which we observe, and on the characteristics of the spouses, which we do not observe. For this reason, in columns (3) and (4), we separately estimate logit models for retirees who choose single life annuities versus joint life annuities. Column (5) includes a separate fixed effect for each calendar year, to capture average changes in macroeconomic conditions

[19] In Table 5, we exclude 251 retirees because we lack data on the location of their most-recent employer. Without these data, we are unable to control for the local unemployment rate. Our inferences are unchanged when we include these retirees and drop our control for the local unemployment rate.

[20] Our inferences are unchanged when we estimate linear probability models instead of logits.

or retiree preferences. Standard errors are clustered on each month in the sample (January 1990, February 1990, …, June 2002) to capture the cross-sectional correlation in economic conditions for retirees making choices in the same month. Inference is similar when we instead cluster standard errors at the employer or county level.

5.2.1. Variation in Retiree Characteristics

When we focus on cross-sectional variation in the value of the incremental life annuity payments caused by differences in retiree characteristics, our findings are broadly consistent with the predictions of life-cycle models. We test for adverse selection in two ways. First, we exploit data on *ex post* mortality. Among retirees who choose a single life annuity, those who die 1-24 months after retirement are 17.7 percentage points more likely to choose the lump sum option (p-value of 0.001), while those who die 25-48 months after retirement are no more likely to do so. This suggests that single retirees' choices are most sensitive to deaths occurring within 24 months of retirement. However, as expected, among retirees who choose a joint life annuity, and are therefore more likely to be maximizing retirement income for both the retiree and spouse, we find weaker evidence at both horizons (*p*-values of 0.065 and 0.091). Second, we find that demand for the lump sum option is lower for female retirees; the difference ranges from 8.2 percentage points (p-value of 0.000) for those choosing single life annuities to 2.7 percentage points (0.000) for those choosing joint life annuities.

Consistent with longevity insurance being less valuable to retirees who are less risk averse, we find that retirees that allocate a positive fraction of their employee contribution to the riskier investment option are more likely to choose the lump sum option. The estimated margin-

al effect ranges from 1.7 to 2.1 percentage points.[21] The fact that police and fire officers are less likely to choose the lump sum option may reflect higher levels of financial risk aversion.

To measure the impact of already-annuitized retirement benefits on the demand for the lump sum option, we include the dollar value of the life annuity payment under the lump sum option (measured in December 2003 dollars). The estimated coefficients are all statistically significant at the 1-percent level. They are also economically significant, with a one-standard deviation increase in monthly life annuity payments ($879) increasing demand for the lump sum between 3.0 and 5.2 percentage points. We obtain similar (unreported) results when we scale the level of already-annuitized monthly income by the retiree's pre-retirement monthly salary.

An interesting exception to the positive relation between already-annuitized income levels and demand for the lump sum option is that, in column (1), we find significantly lower demand for the lump sum option by retirees who are old enough to be receiving Social Security benefits (62+). One interpretation is that younger retirees are more likely to use the lump sum to acquire new skills and re-enter the labor force, whereas older retirees are more likely to permanently exit the labor force. This interpretation may help to explain why, in column (1), we find that individuals retiring before the normal retirement age are 2.7 percentage points more likely to choose the lump sum option. And, it may help to explain why Warner and Pleeter (2001) find much higher demand for lump sum payments by personnel separating from the military (with an average age of 31) than we find by public retirees (with an average age of 59).[22]

As predicted, we find that retirees who spend a larger fraction of their careers with PERS

[21] Although higher demand for lump sum payments by male retirees is potentially consistent with gender-based differences in risk aversion (Barber and Odean (2001)), the estimated marginal effect of the positive allocation to the variable account dummy variable is similar when we restrict the sample to female retirees (2.0 percentage points).

[22] Warner and Pleeter (2001) study the choice between lump sum and non-life annuity payments in a sample of individuals separating from the military. Although the annuities in their sample are also quite valuable, they find strong demand for the lump sum. This is especially true among enlisted personnel, who may need to invest in new skills to re-enter the labor force.

employers have significantly lower demand for the lump sum option, and that the effect is approximately three times larger for retirees choosing the single life annuity.[23] We also find that retirees whose pre-retirement salary are in the top quartile of retirees are between 2.7 and 3.3 percentage points less likely to choose the lump sum option, which is consistent with the possibility that higher salaries proxy for higher levels of financial literacy.

While the arguments in Kotlikoff and Spivak (1981) and Brown and Poterba (2000) predict that single retirees will be less likely to choose the lump sum option, we find that retirees choosing the *single* life annuity are 7.7 to 8.1 percentage points (p-values of 0.000) more likely to choose the lump sum option. One possible explanation is that households respond to the fact that PERS incremental life annuities are better than actuarially fair by having the spouse choose not to annuitize her retirement assets, but we do not observe the annuitization choice of the spouse. Another possible explanation is that retirees recognize that the joint life annuities available from PERS are even better deals than single life annuities.

Overall, these findings lead us to conclude that PERS retirees understand how salient differences in life expectancy, risk aversion, and the level of already-annuitized income impact the value of the incremental life annuity.[24] Given their consistency with other studies, these findings help to allay concerns about the representativeness of our sample.

5.2.2. Variation in Life Annuity Pricing, Economic Conditions, and Investor Sentiment

If retirees recognize and respond to variation in PERS life annuity pricing then demand for the lump sum option should be lower when the value of the incremental life annuity payments is higher. Instead, we find that the natural logarithm of money's worth has a positive and

[23] Controlling for whether the retiree is eligible for "Tier 2" benefits, because she did not contribute into PERS before January 1997, has no additional impact on demand for the lump sum option. Tier 2 members face higher normal retirement ages than other members (60 versus 58), but only account for 85 of the 31,809 retirees in our sample.
[24] Similarly, Barber, Odean and Zheng (2005) find that mutual fund investor flows respond most strongly to those fees that are the most salient.

statistically significant impact on the demand for the lump sum option across all five specifications. In terms of economic significance, a one-standard deviation increase in money's worth increases the probability of choosing the lump sum option by approximately one percentage point in the full sample. While the economic effect is modest, it is the opposite of what we predict. One interpretation is that retirees are confused by variation in the value of incremental life annuity payments that is unrelated to variation in retiree characteristics.

An alternative interpretation is that falling interest rates increase the expected utility of the lump sum payment by even more than they increase the expected utility of the incremental life annuity payments. We consider two possible mechanisms. The first is that lower interest rates increase the expected present value of the life annuity payments under the lump sum option, and that the resulting income effect decreases the relative value of the incremental life annuity. To test this alternative, we estimate (but do not report) two additional versions of the specification in column (2). When we replace the dollar value of the life annuity payment under the lump sum option with the natural logarithm of its expected present value, we continue to find a positive and statistically significant impact on demand for the lump sum option. However, the economic significance is reduced by approximately 20 percent. This suggests that the expected present value is a noisy proxy for the dollar value, which is more salient. When we simultaneously control for the dollar value and the expected present value, the estimated marginal effect on the dollar value is positive and statistically significant while the estimated marginal effect on the expected present value is negative and statistically insignificant. Importantly, the estimated coefficients on the other independent variables—including money's worth—are virtually identical to those reported in column (2).

The second possible mechanism is that lower interest rates proxy for greater economic

uncertainty and that greater economic uncertainty increases the relative value of the lump sum payment. In Table 5, we include the level of VIX to control for macroeconomic uncertainty and the unemployment rate in the county of the retiree's former employer to control for local economic conditions. While our point estimates suggest that demand for the lump sum increases with VIX and decreases with the unemployment rate, the statistical evidence is weak. The more important result is that including these proxies has no impact on the marginal effect associated with money's worth. When we exclude both of these proxies for economic conditions we find (in an unreported specification) that the marginal effect on money's worth remains 0.045. Furthermore, in column (5), we continue to find a positive (albeit approximately 35 percent smaller) relation between money's worth and demand for the lump sum option. Because this specification includes calendar year fixed effects it controls for the average impact of economic conditions within each year.

While it remains possible that low interest rates increase the value of the lump sum payment by more than they increase the value of the incremental life annuity payments, it is worth emphasizing that these increases need to be large. Changes in the risk-free rate cause the payments available from PERS to fluctuate between being 25% and 73% more generous than those available from TIAA.

When we focus on our other proxies for market conditions and investor sentiment in Table 5, we continue to find a strong and statistically significant relation between equity market conditions and demand for the lump sum option. Within the full sample, a one standard deviation increase in the level of NASDAQ is associated with a 2.6 percentage point increase in the probability of choosing the lump sum option. Similarly, a one standard deviation increase in the return on the S&P 500 index over the prior 12 months is associated with a 2.9 percentage point

increase in this probability. In contrast, the return earned in the PERS retirement account over the prior 12 months has no direct effect on the demand for the lump sum option.[25] As we discussed above, the most provocative interpretation of these findings is that retirees are using recent equity market returns—which are likely to be salient—to infer future equity market returns. Unfortunately, because we do not observe whether the lump sum payment is invested in equity, we cannot test for return chasing.

The individual-level data do, however, allow us to test the alternative interpretation that higher equity market returns increase household wealth outside of PERS retirement benefits, which then increases demand for cash or consumption. Specifically, we identify subsamples of retirees for whom the PERS retirement account is likely to be a larger fraction of their total wealth, and then test whether demand for the lump sum option by these retirees is less sensitive to recent equity market returns. Since retirees choosing single life annuities are more likely to be single, they should have fewer sources of outside wealth than retirees choosing joint life annuities. Yet, the marginal effects associated with equity market returns are similar for retirees choosing a single life annuity or a joint life annuity (0.145 versus 0.164). We find similar effects when, in unreported specifications, we focus on the subsample of retirees with 20 or more years of service within PERS (0.154), or the subsample of retirees with 20 or more years of service who choose a single life annuity (0.147).[26] The fact that different subsamples of retirees exhibit similar sensitivity to recent equity market returns argues against an interpretation based on changes in outside wealth.

5.2.3. Exploiting Cross-Sectional and Time-Series Variation in Life Annuity Pricing

[25] Chalmers, Johnson, and Reuter (2008) describe features of PERS that significantly reduce the correlation between the returns on the S&P 500 index and those posted to PERS retirement account balances.

[26] Lusardi and Mitchell (2007) and Lusardi and Tufano (2008) find that financial literacy is lower among women. When we estimate separate specifications for males and females, we find that the estimated sensitivity to lagged equity returns is higher for males (0.174) than females (0.133), but the difference is not statistically significant.

In Table 6, we decompose money's worth into the three terms described by equation (3). The first term is the money's worth of the incremental life annuity that can be purchased from TIAA. Because TIAA adjusts its actuarial equivalency factors each January, in response to changes in the risk-free rate, the money's worth of the life annuity available from TIAA exhibits little variation. Not surprisingly, the estimated coefficient on this term is small and statistically indistinguishable from zero.

The second term, δ, captures plausibly exogenous cross-sectional variation in the dollar value of the incremental life annuity payments arising from the use of multiple benefit formulae. Because retirees always receive the maximum incremental life annuity payments for which they are eligible, variation in money's worth based on how PERS calculates life annuity payments should be uncorrelated with retiree preferences for incremental life annuities versus lump sums. While the predicted coefficient on δ is negative, the estimated coefficient is positive and statistically significant. However, the economic magnitude is small. A one standard deviation increase in δ only increases the probability of choosing the lump sum option by 0.41 percentage points.

Part of the variation in δ arises from the fact that retirees who first contribute into PERS after August 1981 are not eligible for the *DCDB* total life annuity benefit. Among the 21.1% of retirees who are not eligible for *DCDB*, approximately half (10.1% of the full sample) face lower incremental life annuity payments at retirement because of this ineligibility. In column (2), we distinguish variation in the value of incremental life annuity payments due to other sources (δ_1) from variation due to ineligibility for *DCDB* (δ_2). When we focus on δ_2, we finally find evidence that lower money's worth is associated with higher demand for the lump sum option. But, here too, the economic magnitude is small. A one-standard deviation decrease in money's worth due to ineligibility for *DCDB* is associated with a 0.41 percentage point increase in demand for

the lump sum. The dummy variable indicating whether retiree *k* is ineligible for *DCDB* controls for the possibility that individuals accepting jobs as public employees after a reduction in the expected retirement benefits attach less value to life annuities. However, none of the estimated marginal effects are positive and statistically significant.

The third term, θ, measures the money's worth of the incremental life annuity payments under *DC* relative to the money's worth of life annuity payments available from TIAA—the same source of plausibly exogenous time-series variation that we study in Table 4. The estimated coefficient is positive and statistically significant. In terms of economic significance, a one standard deviation increase in the relative value of the incremental life annuities available from PERS is associated with a 2.5 percentage point increase in demand for the lump sum.

To summarize, the evidence that retirees respond to cross-sectional variation in money's worth driven by formulaic eccentricities of the PERS benefit calculations is weak. And, despite our numerous controls for retiree characteristics, economic conditions, and investor sentiment, we find no evidence that demand for the lump sum option responds in the predicted direction to time-series variation in interest rates.

5.2.4. Robustness

We perform robustness tests in the remaining columns of Table 6. In column (3) our goal is to identify retirees whose choice of retirement date is driven more by retirement eligibility than by the level of their retirement benefits, so we restrict the sample to retirees who are 58 years old and for whom the normal retirement age is 58. Our main results hold within this much smaller sample, albeit in some cases with lower levels of statistical significance. They also hold when, in column (4), we include the fraction of the retiree's coworkers that chose the lump sum option over the prior 12 months. We view this specification as controlling for employer-level

heterogeneity in the preference for incremental life annuities versus lump sums.[27]

To explore the possibility that retirees rely on less sophisticated—but more salient—measures than money's worth, we include two additional dummy variables in column (5). The first indicates whether the lump sum payment (measured in December 2003 dollars) is in the top 10% of those offered to PERS retirees; the second indicates whether the incremental life annuity payments (measured in December 2003 dollars) are in the bottom 10% of those offered to PERS retirees. The estimated coefficients on both variables are statistically and economically significant. Retirees facing "large" lump sum payments are 4.6 percentage points more likely to choose the lump sum option, and those facing "small" incremental life annuity payments are 4.6 percentage points more likely to choose the lump sum option.[28] While these findings support the idea that retirees rely on *ad hoc* rules when choosing between the total life annuity and lump sum options, including them has little impact on the estimated coefficients on the other independent variables. In particular, we continue to find that demand for the lump sum option increases (rather than decreases) with the money's worth of the incremental life annuities, and with recent equity market returns.

6. Conclusion

To determine how retirees value life annuities, we compare the actual payout choices of a large sample of Oregon public employees to the predictions of a life-cycle model. Because life annuities provide stable income until death, and because the incremental life annuities available from PERS are better than actuarially fair, we predict that average demand for the lump sum op-

[27] Chalmers, Johnson, and Reuter (2008) provide evidence of peer effects in the retirement timing decision. Here, we have the more modest goal of using coworker behavior to capture otherwise unobservable heterogeneity in retiree preferences.

[28] Based on a survey of 2,600 employees and 2,400 retirees in 2007, Watson Wyatt concludes that "Most employees want a lump sum—if it's big enough." The survey is summarized in "Who Prefers Annuities? Observations About Retirement Decisions," published in April 2008 issue of *Watson Wyatt Insider*.

tion will be low. Consistent with this prediction, we find that 85% of PERS retirees choose the total life annuity option. This is much greater demand for incremental life annuities than has been documented in other settings.

Whether and how retirees respond to variation in the value of life annuity payments, however, depends crucially on the source of variation. When we focus on salient and easily understood variation due to differences in retiree characteristics our findings are consistent with both theory and the existing literature. When we focus on sources of plausibly exogenous variation in life annuity pricing that are unique to our setting, but arguably less salient, our findings are difficult to reconcile with theory. The evidence that retirees respond to cross-sectional variation in life annuity pricing is limited to a single source of variation in the level of the incremental life annuity payments, and the implied elasticity is small. Moreover, when we exploit exogenous variation in life annuity pricing arising from time-series variation in the risk-free rate, we find no evidence that demand for the lump sum option falls when interest rates are lower. Instead, we find that demand for the lump sum option is higher when equity returns have been higher. We believe that these last two findings are best explained by financial illiteracy.

However, an alternative interpretation is that retirees are solving more complicated optimization problems than we appreciate. For example, time-series variation in demand for the lump sum option may be driven by time-series variation in the level of financial constraints. Although it seems unlikely to us that the level of financial constraints increases with recent equity market returns and decreases with the interest rate, we cannot directly test this alternative. Nor can we directly test the alternative that retirees understand that when interest rates fall, the level of PERS underfunding rises, exposing retirees who choose the total lump sum option to greater political risk. However, the level of financial constraints or perceived political risk

would need to increase significantly to justify forgoing life annuity payments with an expected present value of $1.45 (or more) for $1.00 in cash. Finally, what we classify as retiree mistakes may reflect self-interested advice from financial advisors seeking assets under management. It is plausible that it is easier to convince retirees to choose the lump sum option and roll it over to an IRA when recent equity returns are higher and current interest rates are low.

Regardless of how we interpret the impact of interest rates and equity market returns on demand for lump sums, our paper offers two lessons to policy makers interested in increasing annuitization rates. To the extent that we find any evidence that retirees respond rationally to changes in annuity pricing, the effect is small. This suggests that small changes in annuity pricing due, for example, to the introduction of tax subsidies or longevity bonds (Brown and Orszag (2006)) are unlikely to increase annuitization rates by an economically significant amount. On the other hand, the fact that we find high demand for the total life annuity option suggests that retirees may respond strongly to large, salient changes in annuity prices. But, given the evidence in Madrian and Shea (2001) and Bütler and Teppa (2007), we believe that policy makers should explore the efficacy of more cost-effective solutions to low annuitization rates, such as making life annuities the default retirement payout choice in retirement plans.

Appendix. Determinants of PERS Incremental Life Annuity Payments

In this appendix, we describe the formulas used to calculate life annuity payments under the total life annuity and lump sum options. There are four inputs. The first input, x_{DB}, captures the defined benefit aspect of PERS retirement benefits, while the second input, x_{DC}, captures the defined contribution aspect of PERS retirement benefits. Formally,

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

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. AEF_{PERS} depends on age but not gender. The third input is a dummy variable, I_{PF}, that indicates whether the retiree is eligible for police and fire benefits, which are more generous than those available to normal members. The fourth input is a dummy variable, I_{DCDB}, that indicates whether the retiree contributed into PERS by August 1981; if so, the retiree is eligible for total life annuity payments calculated under *DCDB*.

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

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

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). Regardless of which formula gives the maximum total life annuity payment, the level of the life annuity payment under the lump sum option is calculated as the maximum of two possible benefits:

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

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

In Table A1, we calculate two ratios that summarize tradeoffs between the total life annuity and lump sum options. One panel focuses on normal retirees; the other panel focuses on police and fire officers. The first ratio is the incremental life annuity payment divided by the total 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 rows (b) and (c), when *DCDB* offers the highest total life annuity payment, *DCDB*-eligible retirees face larger incremental life annuity payments than *DCDB*-ineligible retirees.

The second ratio, δ, is the money's worth of the actual incremental life annuity payments divided by the money's worth of the incremental life annuity payments under *DC*. Because there are values of *DC* and *DB* for which *DCDB*-ineligible retirees receive lower total life annuity payments—but the same life annuity payments under the lump sum option—there are values of x_{DC} and x_{DB} for which *DCDB*-ineligible retirees will find the lump sum option relatively more attractive. For *DCDB*-eligible retirees, δ equals one when the total life annuity payment is calculated under *DC* and *DCDB*, and is greater than one under *DB*. For *DCDB*-ineligible retirees, however, δ can be as low as 0.65. Note that when δ equals one, variation in δ is driven entirely by retiree age. This reflects that fact that PERS does not adjusts its actuarial equivalency factors during our sample period, and the fact that we estimate the expected present discount value of the incremental life annuity payments available to each retiree using mortality tables from 2004.

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Figure 1. Fraction of PERS Employees choosing lump sum option and lagged stock return, 1990-2002

Monthly time-series plot of the fraction of retirees in each month that choose the 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). Our sample runs from January 1990 to June 2002.

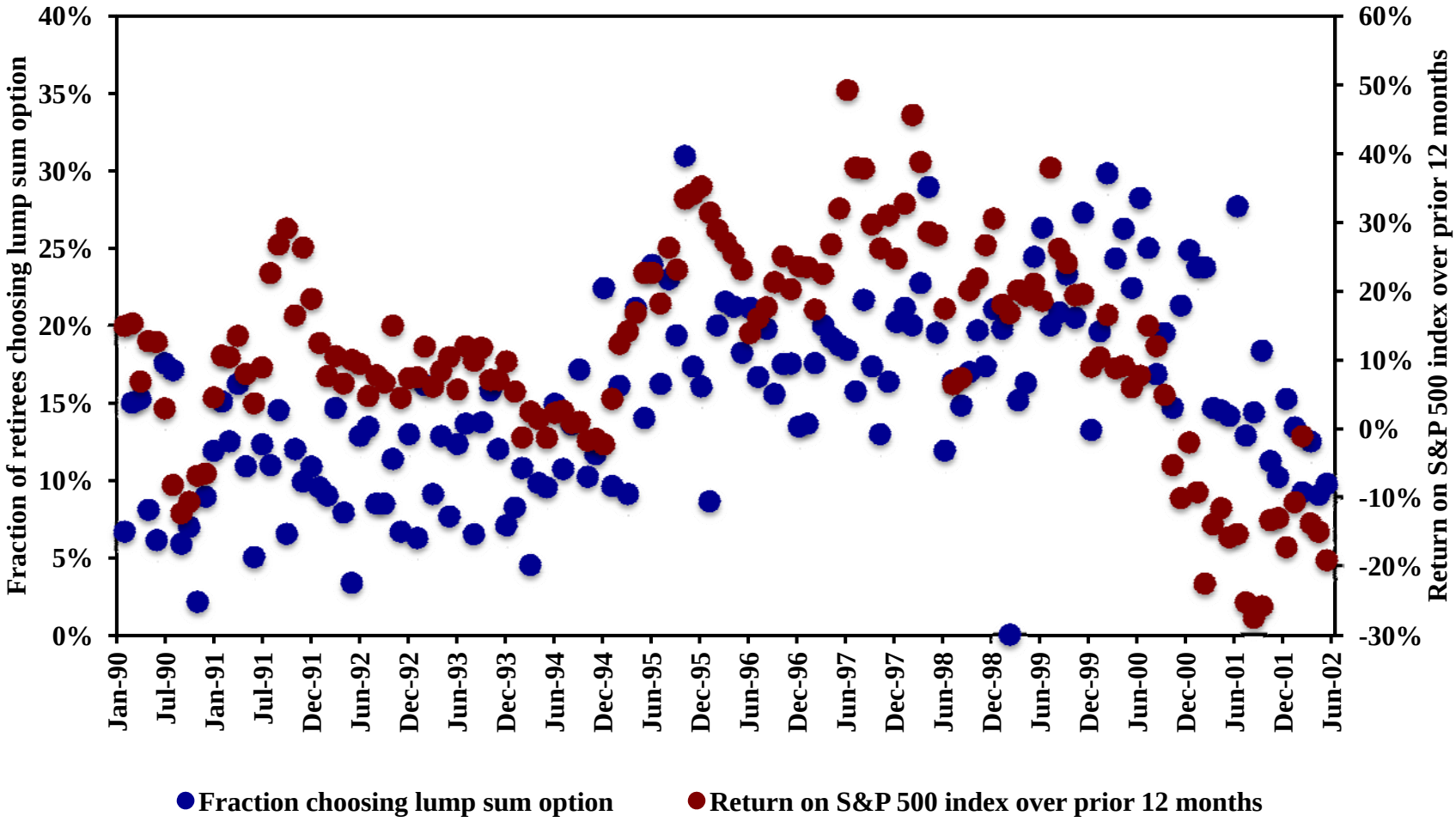

Table 1. Oregon PERS Retirees' Characteristics – January 1990 – June 2002

This table reports summary statistics for individuals between the ages of 50 and 70 retiring from the Oregon Public Employees Retirement System (PERS), who begin collecting retirement benefits immediately after leaving employment. Panels A, B, and C focus on retirees whose total life annuity benefits are calculated under *DC*, *DB*, and *DCDB*, respectively. *Age* reports the average members' age in the month of retirement; *Years of Service* reports the average number of years that the member contributed into PERS; *Monthly Salary* is the average of members' PERS salary averaged over the prior 36 months; *Account Balance* is the average value of the members' PERS retirement account balances at the time of retirement, which determines the size of the 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. *Total Life Annuity* is the average level of the initial monthly payment under the total life annuity option, while *Partial Life Annuity* is the average level of the initial monthly payment under the lump sum option. *Monthly Salary*, *Account Balance, Total Life Annuity*, and *Partial Life Annuity* are converted into December 2003 dollars using the Consumer Price Index.

	# Retirees	*Age*	*Years of Service*	*Monthly Salary*	*PERS Account Balance*	*% Police & Fire*	*% Female*	*% Early Retiree*	*Total Life Annuity*	*Partial Life Annuity*	*Incremental Life Annuity*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Panel A. Retirees for Whom Total Life Annuity Payment Determined by DC											
1990	336	60.6	17.5	$4,555	**$110,538**	3.3%	35.7%	30.4%	$1,921	$961	**$960**
1991	882	60.9	19.2	$4,309	**$123,313**	2.4%	40.0%	23.4%	$2,153	$1,078	**$1,075**
1992	544	61.0	19.7	$4,452	**$119,422**	4.2%	35.1%	27.6%	$2,093	$1,048	**$1,046**
1993	924	60.6	20.8	$4,519	**$133,868**	2.8%	36.6%	27.6%	$2,317	$1,161	**$1,157**
1994	1,104	60.5	21.4	$4,574	**$136,170**	3.0%	41.6%	28.5%	$2,354	$1,180	**$1,175**
1995	1,138	60.3	20.9	$4,265	**$141,662**	3.0%	49.0%	25.3%	$2,434	$1,219	**$1,215**
1996	1,220	60.2	21.9	$4,315	**$142,426**	2.8%	47.5%	23.2%	$2,443	$1,225	**$1,217**
1997	1,785	59.8	21.7	$4,359	**$155,781**	4.3%	52.8%	23.9%	$2,667	$1,337	**$1,330**
1998	3,635	59.1	22.2	$4,469	**$174,448**	4.4%	53.6%	33.6%	$2,941	$1,473	**$1,467**
1999	3,614	58.5	21.7	$4,528	**$181,613**	6.0%	54.8%	38.0%	$3,020	$1,513	**$1,507**
2000	1,691	58.3	20.8	$4,484	**$178,727**	8.4%	55.5%	38.6%	$2,954	$1,482	**$1,472**
2001	2,311	58.4	22.2	$4,603	**$188,586**	7.4%	55.6%	32.2%	$3,126	$1,567	**$1,558**
2002	2,089	58.3	23.2	$4,726	**$197,325**	6.8%	57.1%	34.3%	$3,268	$1,641	**$1,627**

Table 1 – (continued)

	# Retirees	*Age*	*Years of Service*	*Monthly Salary*	*PERS **Account Balance***	*% Police & Fire*	*% Female*	*% Early Retiree*	*Total Life Annuity*	*Partial Life Annuity*	*Incremental Life Annuity*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Panel B. Retirees for Whom Total Life Annuity Payment Determined by DB											
1990	299	58.8	22.6	$4,413	**$73,329**	17.1%	44.1%	4.0%	$1,829	$1,136	**$693**
1991	180	59.5	19.1	$4,203	**$56,450**	20.0%	45.0%	7.2%	$1,531	$956	**$575**
1992	272	59.9	17.7	$4,397	**$57,921**	19.1%	46.7%	7.0%	$1,468	$918	**$551**
1993	276	61.2	14.8	$4,080	**$41,867**	19.6%	43.5%	5.8%	$1,149	$725	**$423**
1994	496	60.5	16.0	$4,242	**$51,231**	16.1%	48.2%	7.3%	$1,303	$816	**$487**
1995	186	61.1	11.4	$3,507	**$27,484**	10.8%	52.7%	11.3%	$643	$392	**$251**
1996	316	60.8	12.1	$4,004	**$37,218**	13.9%	52.2%	5.1%	$891	$553	**$338**
1997	248	60.2	12.8	$4,063	**$40,179**	16.9%	57.3%	11.7%	$915	$566	**$349**
1998	197	60.1	13.4	$4,129	**$41,022**	19.3%	60.9%	17.8%	$977	$604	**$373**
1999	182	60.0	12.9	$3,766	**$35,421**	22.5%	54.4%	15.9%	$829	$514	**$315**
2000	106	60.1	11.2	$4,235	**$36,803**	20.8%	37.7%	14.2%	$842	$521	**$322**
2001	198	60.2	12.6	$4,303	**$42,585**	15.7%	48.5%	13.6%	$973	$599	**$374**
2002	198	60.5	11.5	$4,179	**$36,480**	15.2%	60.6%	14.6%	$827	$508	**$319**
Panel C. Retirees for Whom Total Life Annuity Payment Determined by DCDB											
1990	986	60.5	20.3	$3,932	**$78,888**	6.3%	52.8%	13.2%	$1,523	$844	**$679**
1991	814	59.4	22.0	$4,007	**$94,574**	14.1%	54.1%	9.5%	$1,773	$984	**$789**
1992	1,059	59.7	22.4	$4,262	**$97,160**	13.4%	49.1%	12.5%	$1,855	$1,034	**$822**
1993	973	59.5	22.7	$4,284	**$102,521**	14.0%	57.8%	10.6%	$1,928	$1,065	**$863**
1994	1,575	58.9	23.5	$4,469	**$110,164**	15.6%	56.6%	11.1%	$2,066	$1,150	**$916**
1995	313	58.5	21.2	$4,247	**$102,851**	23.3%	65.2%	9.9%	$1,864	$1,025	**$839**
1996	537	57.9	23.0	$4,609	**$120,323**	24.6%	58.7%	8.8%	$2,187	$1,214	**$973**
1997	424	56.5	23.6	$5,205	**$149,493**	46.0%	46.5%	11.1%	$2,707	$1,515	**$1,192**
1998	338	55.8	23.9	$5,496	**$174,017**	59.5%	42.3%	16.9%	$3,039	$1,667	**$1,372**
1999	269	55.5	24.6	$6,078	**$206,041**	65.8%	33.1%	11.5%	$3,544	$1,923	**$1,621**
2000	86	54.6	24.9	$6,413	**$228,500**	74.4%	29.1%	8.1%	$3,905	$2,128	**$1,777**
2001	135	54.9	24.9	$6,385	**$220,348**	63.0%	38.5%	11.1%	$3,736	$2,019	**$1,717**
2002	124	55.9	24.6	$6,132	**$204,709**	55.6%	47.6%	16.9%	$3,514	$1,897	**$1,617**

Table 2. Comparing Money's Worth of Life Annuities available from PERS and TIAA, 1990-2002

We compare the money's worth of life annuities based on PERS' *DC* benefit to the money's worth of TIAA's life annuities. We assume that the retiree is 65 years 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. During our sample period, PERS does not adjust its *AEFs*, while TIAA adjusts its *AEFs* in January of each calendar year, to reflect changes in member life expectancies or 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 is assumed to be constant. 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 the 10-Year U.S. Treasury Note at the end of the prior month. The average annual yield is reported in column 10. We calculate money's worth of each life annuity as the expected present value of its life annuity payments relative to its price (i.e., as (AEF times EPV) divided by $1,000). In column (9), we calculate the money's worth of the PERS life annuity relative to the money's worth of the TIAA life annuity (that is, θ equals (AEF_{PERS} times $EPV_{2\%}$) divided by (AEF_{TIAA} times $EPV_{0\%}$). When θ equals one, PERS and TIAA allow retirees to purchase the same expected present value of life annuity benefits per dollar of initial outlay. Values greater than one, as observed in this table, imply that PERS sells more valuable life annuity benefits than TIAA. The bottom row reports the pairwise correlation between the yield on the 10-year U.S. Treasury Note and AEF, EPV, and MW.

	PERS			**TIAA**			**PERS relative to TIAA**			**Yield on 10-Year**
Year	AEF	EPV	MW	AEF	EPV	MW	AEF	EPV	θ	**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	8.43%
1991	9.79	119.51	1.17	8.75	102.19	0.89	1.12	1.17	1.31	8.03%
1992	9.79	126.22	1.24	8.52	107.41	0.92	1.15	1.18	1.35	7.31%
1993	9.79	135.81	1.33	7.72	114.84	0.89	1.27	1.18	1.50	6.39%
1994	9.79	145.37	1.42	7.10	122.20	0.87	1.38	1.19	1.64	5.64%
1995	9.79	123.27	1.21	7.72	105.12	0.81	1.27	1.17	1.49	7.59%
1996	9.79	145.37	1.42	7.10	122.20	0.87	1.38	1.19	1.64	5.58%
1997	9.79	134.68	1.32	7.34	113.97	0.84	1.33	1.18	1.58	6.50%
1998	9.79	146.64	1.44	7.03	123.18	0.87	1.39	1.19	1.66	5.51%
1999	9.79	157.50	1.54	6.61	131.47	0.87	1.48	1.20	1.77	4.65%
2000	9.79	132.48	1.30	7.39	112.27	0.83	1.33	1.18	1.56	6.67%
2001	9.79	150.57	1.47	7.08	126.18	0.89	1.38	1.19	1.65	5.18%
2002	9.79	153.28	1.50	6.77	128.25	0.87	1.45	1.20	1.73	5.03%
Correl.	*0.000*	*-0.998*	*-0.998*	*0.935*	*-0.998*	*-0.028*	*-0.945*	*-0.999*	*-0.955*	—

Table 3. Percent of PERS Retirees Choosing Lump Sum Option, by Retirement Calculation Method, 1990-2002

This table summarizes the demand for lump sum options across years and across retirees for whom the total life annuity benefit is calculated using *DC, DB,* or *DCDB*. The sample is the same one that we summarized in Table 1. *% Lump* reflects the fraction of retirees choosing the lump sum option. *MW* is the money's worth of the total life annuity option relative to the lump sum option. It is defined as the expected present value of the life annuity payments under the total life annuity option minus those under the lump sum option, divided by the lump sum payout. We report the median value of *MW* each year.

	All Retirees			***DC***			***DB***			***DCDB***		
Year	*# Retirees*	*% Lump*	*MW*	*# Retirees*	*% Lump*	*MW*	*# Retirees*	*% Lump*	*MW*	*# Retirees*	*% Lump*	*MW*
1990	1,621	8.6%	$1.16	336	7.1%	$1.12	299	9.4%	$1.24	986	8.8%	$1.15
1991	1,876	8.6%	$1.21	882	7.9%	$1.20	180	15.0%	$1.29	814	7.9%	$1.21
1992	1,875	6.9%	$1.30	544	7.2%	$1.28	272	11.0%	$1.38	1,059	5.7%	$1.31
1993	2,173	9.7%	$1.47	924	9.2%	$1.42	276	18.8%	$1.54	973	7.6%	$1.52
1994	3,175	10.4%	$1.26	1,104	11.4%	$1.24	496	14.3%	$1.31	1,575	8.5%	$1.27
1995	1,637	16.4%	$1.40	1,138	16.8%	$1.40	186	22.6%	$1.30	313	11.2%	$1.47
1996	2,073	18.1%	$1.39	1,220	18.2%	$1.37	316	20.6%	$1.32	537	16.4%	$1.40
1997	2,457	17.9%	$1.43	1,785	18.8%	$1.43	248	22.2%	$1.28	424	11.6%	$1.45
1998	4,170	20.5%	$1.59	3,635	21.0%	$1.59	197	23.9%	$1.48	338	12.7%	$1.60
1999	4,065	20.4%	$1.51	3,614	20.5%	$1.51	182	22.0%	$1.35	269	18.2%	$1.51
2000	1,883	21.7%	$1.48	1,691	21.4%	$1.50	106	28.3%	$1.29	86	19.8%	$1.47
2001	2,644	15.9%	$1.63	2,311	15.7%	$1.63	198	18.7%	$1.48	135	15.6%	$1.64
2002	2,411	10.6%	$1.67	2,089	10.4%	$1.67	198	11.6%	$1.58	124	12.1%	$1.68
Total	32,060	15.0%	$1.45	21,273	16.6%	$1.49	3,154	17.3%	$1.36	7,633	9.6%	$1.33

Table 4. Predicting Average Monthly Demand for Lump Sum Option, 1990-2002

We report coefficients from time-series regressions estimated via weighted least squares. The sample consists of the 150 months between January 1990 and June 2002. The dependent variable is the fraction of PERS retirees who choose the lump sum option in month *t*. The weight in month *t* is the number of retiree choices used to calculate this fraction. Independent variables include the ratio of the actuarial equivalency factor available from PERS (under the DC formula) to the life annuity payment available from TIAA (i.e., column (7) of Table 2), the return on the S&P 500 index over the prior 12 months, the implied volatility on the S&P 500 index option over the month t as measured by CBOE Volatility Index (VIX) at the end of month t-1, and the inflation-adjusted level of NASDAQ measured at the end of month t-1. Variables in columns (1) through (4) are measured as levels. Variables in column (5) are measured as first differences, which results in the loss of one observation. Standard errors are reported in parentheses and calculated as in Newey and West (1987), with a lag of 24 months. Significance at the 10%, 5%, and 1% levels are denoted by *, **, and ***.

Estimation:	Levels (1)	Levels (2)	Levels (3)	Levels (4)	1st Differences (5)
Relative Generosity of PERS Life Annuity	0.268 ***	0.265 ***	0.206 ***	0.111 ***	0.322 *
	(0.069)	(0.038)	(0.048)	(0.039)	(0.185)
Return on S&P 500 Index over prior 12 months		0.160 ***	0.174 ***	0.144 ***	0.071 *
		(0.042)	(0.036)	(0.028)	(0.041)
Level of VIX index at end of prior month			0.289 **	0.100	0.119
			(0.131)	(0.092)	(0.124)
Inflation-adjusted level of NASDAQ index at end of prior month				0.005 ***	0.001
				(0.001)	(0.002)
Constant	-0.182	-0.195 ***	-0.180 ***	-0.073	-0.009 **
	(0.080)	(0.049)	(0.057)	(0.048)	(0.004)
Number of monthly observations	150	150	150	150	149
F-Statistic	15.07 ***	37.55 ***	23.39 ***	31.64 ***	2.67 **

Table 5. Predicting Individual Demand for Lump Sum Option, 1990-2002

We report marginal effects estimated via logit. The dependent variable equals one when retiree k chooses the lump sum option, and zero when retiree k chooses the total life annuity option. Columns (1), (2), and (5) focus on the full sample of retirees; column (3) is restricted to retirees who choose a single life annuity; column (4) is restricted to retirees who choose a joint life annuity. All specifications include a separate fixed effect for each year of service. Columns (2) through (4) include a separate fixed effect for each year of age between 50 and 70. Column (5) includes a separate fixed effect for each calendar year. We include dummy variables indicating whether retiree *k*: dies 1-24 months after retirement; dies 25-48 months after retirement; is female; has a positive allocation to the variable investment vehicle in the PERS retirement account; is eligible for police or fire retirement benefits; chooses a single life annuity; is retiring before the normal retirement age (55 for police and fire; 58 for almost everyone else); has a pre-retirement salary in the top quarter of retirees; receives Tier 2 retirement benefits; or is old enough to collect Social Security benefits (62+). We also control for the level of the life annuity payments under the lump sum option (measured in December 2003 dollars), and the estimated fraction of retiree k's career spent working with PERS employers. *Ln Money's Worth* is the natural logarithm of the expected present value of the incremental life annuity payments associated with choosing the total life annuity option over the lump sum option, divided by the lump sum payout. Our proxies for economic conditions and investor sentiment include the current unemployment rate in the county of retiree k's most recent employer, the level of the CBOE Volatility Index (VIX) at the end of month *t-1*, the inflation-adjusted level of the NASDAQ index at the end of month *t-1*, the return on the S&P 500 index over the prior 12 months, and the return earned in the PERS retirement account over this same period. Standard errors are clustered on calendar month (e.g., June 2002). Significance at the 10%, 5%, and 1% levels are denoted by *, **, and ***.

Sample:	Full		Full		Single Life		Joint Life		Full	
	(1)		(2)		(3)		(4)		(5)	
Retiree Characteristics										
Dies 1-24 months after retirement?	0.085	***	0.086	***	0.177	***	0.042	*	0.090	***
	(0.024)		(0.024)		(0.048)		(0.022)		(0.024)	
Dies 25-48 months after retirement?	0.014		0.016		-0.025		0.036	*	0.017	
	(0.017)		(0.017)		(0.029)		(0.021)		(0.017)	
Female?	-0.046	***	-0.047	***	-0.082	***	-0.027	***	-0.049	***
	(0.007)		(0.007)		(0.011)		(0.007)		(0.008)	
Positive allocation to variable investment vehicle?	0.021	***	0.020	***	0.017	**	0.021	***	0.019	***
	(0.005)		(0.005)		(0.008)		(0.005)		(0.005)	
Eligible for police or fire benefits?	-0.009		-0.021	***	-0.018		-0.022	***	-0.020	***
	(0.007)		(0.008)		(0.017)		(0.007)		(0.008)	
Level of partial life annuity ($000, Dec 2003)	0.035	***	0.036	***	0.052	***	0.031	***	0.030	***
	(0.003)		(0.003)		(0.008)		(0.004)		(0.004)	
Chooses single life annuity?	0.077	***	0.077	***					0.081	***
	(0.005)		(0.005)						(0.004)	
Estimated fraction of career spent Working for PERS employers	-0.191	***	-0.733	***	-1.228	***	-0.400	***	-0.737	***
	(0.067)		(0.097)		(0.156)		(0.141)		(0.093)	
Salary at or above 75th percentile (within calendar year)?	-0.031	***	-0.032	***	-0.033	***	-0.032	***	-0.027	***
	(0.005)		(0.005)		(0.010)		(0.006)		(0.005)	
Retiring before normal retirement age?	0.027	***	0.006		0.018		0.001		0.005	
	(0.006)		(0.011)		(0.023)		(0.011)		(0.010)	
Tier 2 retirement benefits?	-0.033		-0.031		-0.051		-0.017		-0.027	
	(0.027)		(0.028)		(0.034)		(0.048)		(0.027)	
Old enough to collect Social Security benefits (62+)?	-0.038	***								
	(0.007)									
Value of Incremental Life Annuity										
Ln Money's Worth	0.045	***	0.044	***	0.045	**	0.045	***	0.029	***
	(0.013)		(0.014)		(0.021)		(0.016)		(0.011)	
Retiree Not Eligible for *DCDB?*	-0.016	***	-0.016	***	-0.035	***	-0.007		-0.032	***
	(0.006)		(0.006)		(0.012)		(0.007)		(0.007)	
Economic Conditions and Investor Sentiment										
Local unemployment rate	-0.167		-0.174		-0.029		-0.271		-0.005	
	(0.182)		(0.182)		(0.279)		(0.176)		(0.125)	

Level of VIX at end of month *t-1*	0.112		0.109		0.168		0.077		0.019	
	(0.095)		(0.094)		(0.150)		(0.083)		(0.084)	
Inflation-adjusted level of NASDAQ	0.005	***	0.005	***	0.006	***	0.005	***	0.002	
index at end of month *t-1*	(0.001)		(0.001)		(0.001)		(0.001)		(0.001)	
Return on S&P 500 index	0.155	***	0.155	***	0.145	***	0.164	***	0.064	
over prior 12 months	(0.034)		(0.034)		(0.052)		(0.030)		(0.050)	
Return in PERS retirement account	-0.060		-0.066		-0.025		-0.096		0.017	
over prior 12 months	(0.102)		(0.102)		(0.158)		(0.088)		(0.074)	
Years-of-Service FEs?	Yes		Yes		Yes		Yes		Yes	
Age-in-Years FEs?	---		Yes		Yes		Yes		Yes	
Calendar Year FEs?	---		---		---		---		Yes	
Sample Size	31,809		31,809		11,500		20,309		31,809	
Pseudo R^2	0.0498		0.0534		0.0634		0.0432		0.0592	

Table 6. Predicting Individual Demand for Lump Sum Option – Alternative Specifications

We report marginal effects estimated via logit. The dependent variable equals one when retiree k chooses the lump sum option and zero when the retiree chooses the total life annuity option. Columns (1), (2), and (5) focus on the full sample of PERS retirees; column (3) is restricted to retirees who are 58 years old and not eligible for police or fire benefits; column (4) is restricted to retirees for whom we can calculate the fraction of co-workers who chose the lump sum option in the past 12 months. Our measures of the value of the incremental life annuity payments are based on the following decomposition:

$$MW_{Max}^{k} = \left[MW_{TIAA}^{k} \right] \times \left[\frac{MW_{Max}^{k}}{MW_{DC}^{k}} \right] \times \left[\frac{MW_{DC}^{k}}{MW_{TIAA}^{k}} \right] = \left[MW_{TIAA}^{k} \right] \times \left[\delta^{k} \right] \times \left[\theta^{k} \right]$$

where MW_{TIAA} is the money's worth of the incremental life annuity available from TIAA, MW_{DC} is the money's worth of the incremental life annuity available from PERS assuming that the total and partial life annuity payments are both calculated under DC, and MW_{Max} is the money's worth of the incremental life annuity available from PERS based on the maximum total and partial life annuity payments that retiree k is eligible to receive. In column (2), we decompose δ further:

$$\delta^{k} = \left[\frac{MW_{Max}^{k}}{MW_{DC}^{k}} \right] = \left[\frac{MW_{Hyp.\ Max}^{k}}{MW_{DC}^{k}} \times \frac{MW_{Max}^{k}}{MW_{Hyp.\ Max}^{k}} \right] = \left[\delta_{1}^{k} \times \delta_{2}^{k} \right]$$

where $MW_{Hyp.\ Max}$ is the money's worth of the incremental life annuity payments available from PERS assuming that retiree *k* is eligible for total life annuity payments calculated under *DCDB*. In addition, we include dummy variables indicating whether retiree *k* is ineligible for total life annuity payments calculated under *DCDB*, has access to a lump sum payment in the top 10% of all lump sum payments during our sample period, or has access to incremental life annuity payments in the bottom 10% of all incremental life annuity payments during our sample period. We also include the fraction of retiree *k*'s coworkers who chose the lump sum option in the prior 12 months (set to missing when retiree *k* is the only retiree from the employer in the prior 12 months). All other variables are defined in the notes to Table 5. Standard errors cluster on the date of the payout choice (e.g., June 2002). Significance at the 10%, 5%, and 1% levels are denoted by *, **, and ***.

Sample:	Full		Full		Age 58		Peer Choices		Full	
	(1)		(2)		(3)		(4)		(5)	
Retiree Characteristics										
Dies 1-24 months after retirement?	0.090	***	0.090	***	0.140	**	0.079	***	0.089	***
	(0.024)		(0.024)		(0.071)		(0.025)		(0.024)	
Dies 25-48 months after retirement?	0.017		0.017		0.037		0.005		0.019	
	(0.017)		(0.017)		(0.049)		(0.017)		(0.017)	
Female?	-0.053	***	-0.053	***	-0.051	***	-0.052	***	-0.055	***
	(0.010)		(0.010)		(0.016)		(0.010)		(0.010)	
Positive allocation to variable	0.021	***	0.021	***	0.007		0.023	***	0.022	***
investment vehicle?	(0.005)		(0.005)		(0.013)		(0.005)		(0.005)	
Eligible for police or fire benefits?	-0.021	***	-0.024	***	-0.033		-0.022	***	-0.016	**
	(0.008)		(0.008)		(0.047)		(0.008)		(0.008)	
Level of partial life annuity	0.031	***	0.032	***	0.025	***	0.033	***	0.019	***
($000, Dec 2003)	(0.004)		(0.004)		(0.009)		(0.004)		(0.005)	
Chooses single life annuity?	0.080	***	0.080	***	0.053	***	0.078	***	0.080	***
	(0.005)		(0.005)		(0.013)		(0.005)		(0.005)	
Estimated fraction of career spent	-0.753	***	-0.744	***	0.563		-0.733	***	-0.766	***
working for PERS employers	(0.095)		(0.094)		(0.511)		(0.107)		(0.094)	
Salary at or above 75th percentile	-0.028	***	-0.028	***	0.001		-0.028	***	-0.026	***
(within calendar year)?	(0.005)		(0.005)		(0.015)		(0.005)		(0.005)	
Retiring before normal retirement	0.004		0.005		0.208		0.004		0.004	
age?	(0.010)		(0.010)		(0.419)		(0.011)		(0.011)	
Tier 2 retirement benefits?	-0.037		-0.035				-0.013		-0.039	
	(0.025)		(0.026)				(0.036)		(0.025)	
Fraction of coworkers who chose							0.094	***		
lump sum in prior 12 month							(0.014)			

Value of Incremental Life Annuity															
Ln MW of life annuity from TIAA	0.033		0.032		-0.018		0.033		0.029	
	(0.061)		(0.061)		(0.115)		(0.062)		(0.061)	
Ln (MW DC / MW TIAA) = Ln θ	0.233	***	0.232	***	0.188	*	0.229	***	0.232	***
	(0.070)		(0.070)		(0.107)		(0.084)		(0.070)	
Ln (MW Max / MW DC) = Ln δ	0.029	**			-0.014		0.030	**	0.027	**
	(0.012)				(0.055)		(0.015)		(0.011)	
Ln (MW Hyp. Max / MW DC)			0.038	***						
= Ln δ_1			(0.012)							
Ln (MW Max / MW Hyp. Max)			-0.097	**						
= Ln δ_2			(0.044)							
Retiree Not Eligible for *DCDB?*	-0.027	***	-0.032	***	-0.010		-0.021	***	-0.028	***
	(0.007)		(0.007)		(0.015)		(0.007)		(0.007)	
Lump Sum in Top 10%?									0.046	***
									(0.012)	
Incremental Life Annuity Payments									0.046	***
in Bottom 10%?									(0.011)	
Economic Conditions and Investor Sentiment										
Local unemployment rate	-0.222		-0.222		-0.311		-0.244		-0.235	
	(0.178)		(0.179)		(0.280)		(0.183)		(0.181)	
Level of VIX at end of month *t-1*	0.021		0.021		0.115		-0.029		0.024	
	(0.100)		(0.100)		(0.159)		(0.103)		(0.099)	
Inflation-adjusted level of NASDAQ	0.004	***	0.004	***	0.003	*	0.004	***	0.004	***
index at end of month *t-1*	(0.001)		(0.001)		(0.002)		(0.001)		(0.001)	
Return on S&P 500 index	0.146	***	0.145	***	0.143	**	0.151	***	0.149	***
over prior 12 months	(0.032)		(0.032)		(0.058)		(0.032)		(0.031)	
Return in PERS retirement account	-0.068		-0.065		0.058		-0.073		-0.068	
over prior 12 months	(0.091)		(0.091)		(0.166)		(0.098)		(0.090)	
Years-of-Service FEs?	Yes		Yes		Yes		Yes		Yes	
Age-in-Years FEs?	Yes		Yes		Yes		Yes		Yes	
Sample Size	31,809		31,809		4,254		28,762		31,809	
Pseudo R2	0.0556		0.0559		0.0574		0.0540		0.0577	

Table A1. Tradeoffs Between Total Life Annuity Option and Lump Sum Option

This table summarizes tradeoffs between the total life annuity and lump sum options for retirees for whom the 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. I_{DCDB} is a dummy variable that indicates whether the retiree contributed into PERS by August 1981, making her eligible for *DCDB* total life annuity benefits. Panel A focuses on normal retirees (I_{PF}=0) and Panel B focuses on police and fire (I_{PF}=1). 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) $\boldsymbol{x_{DC}} < 0.00670\ \boldsymbol{x_{DB}}$, (b) $0.00670\ \boldsymbol{x_{DB}} \le \boldsymbol{x_{DC}} < 0.00835\ \boldsymbol{x_{DB}}$, (c) $0.00835\ \boldsymbol{x_{DB}} \le \boldsymbol{x_{DC}} < 0.01\ \boldsymbol{x_{DB}}$, and (d) $\boldsymbol{x_{DC}} \ge 0.01\ \boldsymbol{x_{DB}}$. For police and fire, the four rows correspond to $\boldsymbol{x_{DC}} < 0.00650\ \boldsymbol{x_{DB}}$, $0.00650\ \boldsymbol{x_{DB}} \le \boldsymbol{x_{DC}} < 0.01\ \boldsymbol{x_{DB}}$, $0.01\ \boldsymbol{x_{DB}} \le \boldsymbol{x_{DC}} < 0.01350\ \boldsymbol{x_{DB}}$, and $\boldsymbol{x_{DC}} \ge 0.01350\ \boldsymbol{x_{DB}}$. *TLA* is the level of the life annuity payment associated with the total life annuity option and *PLA* is the level of the life annuity payment associated with the lump sum option. The term δ (which appears in equation (3)) measures the money's worth of the forgone life annuity payments associated with choosing the lump sum option relative to case (d), when the total life annuity and lump sum life annuity are both calculated using *DC*.

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

	TLA Benefit		*(TLA - PLA) / TLA*		δ	
	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
(b)	*DCDB*	*DB*	(0.401, 0.443)	0.401	1	[0.802, 1.000]
(c)	*DCDB*	*DC*	(0.443, 0.500)	(0.401, 0.500)	1	[0.802, 1.000]
(d)	*DC*	*DC*	0.500	0.500	1	1

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

	TLA Benefit		*(TLA - PLA) / TLA*		δ	
	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
(b)	*DCDB*	*DB*	(0.325, 0.426)	0.325	1	[0.650, 1.000]
(c)	*DCDB*	*DC*	(0.426, 0.500)	(0.325, 0.500)	1	[0.650, 1.000]
(d)	*DC*	*DC*	0.500	0.500	1	1