The Effect of Annuities on Longevity

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Abstract

We examine how annuities affect longevity using administrative payout data on approximately 600,000 Chilean retirees from 2004 to 2022. To address selection, we exploit the fact that annuity sales vary with recent market returns, a pattern consistent with extrapolative beliefs. We find that the decision to annuitize—instrumented by recent market returns—reduces mortality meaningfully at five- and ten-year horizons. Further analyses indicate that annuities operate by protecting retirees from income volatility and investment-related stress. Complementary survey evidence suggests that annuitants invest more in health and report lower disability rates.

Keywords: annuities; retirement; longevity; post-retirement health; extrapolative beliefs.

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1 Introduction

As populations age, many countries are cutting back on public pension benefits and healthcare spending (OECD, 2025). To address pension shortfalls, governments have promoted employer-sponsored plans and individual retirement accounts. Firms facing similar demographic pressures have shifted from defined benefit to defined contribution plans. Public pension systems and defined benefit plans typically provide benefits through annuities, while individual retirement accounts and defined contribution plans offer lump-sum payouts. In frictionless markets, retirees could offset any reduction in annuitized wealth by purchasing annuities privately. However, annuity sales have historically been low, a puzzling phenomenon noted since Yaari (1965) and Modigliani (1986).

Given these trends, many retirees may experience a substantial reduction in the portion of their retirement wealth automatically converted into annuities. How does this reduction in annuities affect retirees' health and longevity? What are the implications of losing a steady income stream for life, particularly as governments simultaneously reduce public healthcare funding? In this paper, we address these questions by providing evidence on the impact of annuities on retirees' longevity.

Previous studies document that annuitants live longer than non-annuitants (Finkelstein and Poterba 2002, and Brown, Mitchell, and Poterba 2002). This evidence is generally interpreted through the lens of adverse selection models, consistent with individuals acting on private information about their longevity when making annuitization choices (e.g., Finkelstein and Poterba 2004). Our paper complements the existing literature on selection effects in annuitization by examining whether annuities have direct effects on longevity.

Annuities can affect longevity through several interconnected channels. Annuities

provide a stable source of lifetime income, preventing retirees from running out of money. They also shield retirees from income uncertainty and anxiety associated with adverse financial market movements. Higher earnings and lower earnings volatility can increase both immediate and long-term longevity, consistent with evidence on job displacements in Sullivan and von Wachter (2009a,b). Similarly, stock market fluctuations can lead to stress, diminished mental health, and ultimately higher short-term mortality (Engelberg and Parsons 2016, Schwandt 2018). Finally, life-contingent payments from annuities can promote health investments (Philipson and Becker 1998), thereby improving health later in life and reducing mortality.

We use administrative payout data on approximately 600,000 Chilean retirees from 2004 to 2022. At retirement, Chileans face a choice between annuities and phased withdrawals (PW). While annuity payments are constant (in inflation-adjusted terms), phased withdrawal payouts vary with recent market returns. To account for selection effects, we use the returns on the most widely held pension fund during the six months before retirement as an instrument for the decision to annuitize. Our instrument is based on a well-documented pattern: people are more likely to buy annuities after poor market returns, and are less likely to buy annuities after good returns (Chalmers and Reuter 2012, Previtero 2014). This pattern occurs because retirees hold extrapolative beliefs, expecting recent market trends to persist. As a result, recent pension fund returns provide a plausibly exogenous shock to the propensity to annuitize. The intuition behind our instrument is that the pension fund return in the *six months* before, for example, someone's 65th birthday, should affect mortality *several years later* only through the annuitization choice. In our preferred specification, a two-stage least squares (2SLS) regression with, among other controls, retirement-year fixed effects to account for business cycle conditions and birth-year fixed effects to account for cohort differences, we document that annuities

increase longevity by 2.55% at the five-year horizon and by 3.62% at the ten-year horizon. These estimates indicate a positive and economically significant effect of annuities on longevity.

Studying the Chilean public pension system offers several advantages. In 1980, Chile replaced its public pay-as-you-go pension system with privately-managed defined-contribution retirement accounts. Therefore, we can study Chilean retirees' payout choices over a period long enough to detect effects on longevity. We can access administrative data on payout choices and longevity, thereby minimizing measurement error from self-reported data. Next, the payout options within the Chilean system differentially provide resources in the years after retirement. PW payments are more front-loaded and volatile. They start at a higher level but vary with market returns and residual lifespan — the longer someone lives, the lower the payments become. In contrast, annuity payments are more stable and back-loaded because they are inflation-adjusted and life-contingent. Consequently, differences in resource uncertainty and timing can affect retirees' longevity directly or indirectly. Lastly, annuities are popular among Chilean retirees, with approximately two-thirds choosing one, which reduces concerns about potential adverse selection in this market. A long time series of administrative data, the differential uncertainty of payout options, and the popularity of annuities make the Chilean pension system a unique laboratory for studying the effects of annuities on longevity.

We report three sets of results, which we organize around the relevance of our instrument (the first stage of the 2SLS setup), the effect of the instrumented decision to annuitize on longevity (the second stage), and potential mechanisms.

We first test the relevance of our instrument. We document a strong, significant negative correlation between annuitization and the previous 6-month pension fund returns in the raw data (-0.51). In our (first-stage) regressions, we find that a one-standard-

deviation increase in returns reduces the likelihood of choosing an annuity by 2.7%. Given that we include retirement-year fixed effects to account for broader economic conditions, our specification exploits within-year variation in exposure to recent returns. While we partial out a substantial fraction of the variation in the demand for annuities through fixed effects and other control variables (e.g., balance at retirement), the first-stage F-test is comfortably above the threshold that would suggest a weak-instrument problem.

We provide evidence consistent with the idea that extrapolative beliefs (Greenwood and Shleifer, 2014) drive the relation between past returns and annuitization. The tendency to extrapolate is stronger among less sophisticated investors and financial nonprofessionals (Da, Huang, and Jin 2021), and among older investors, who are more cognitively impaired and more likely to suffer biases (Previtero 2014). When we investigate the characteristics of compliers in our IV setting, we find evidence consistent with these studies and, thus, with extrapolative beliefs. In fact, the compliers in our setup are less likely to be sophisticated (i.e., they have lower balances, fewer years of pension contributions, and lower replacement rates) and are more likely to be older. Moreover, we document that only *recent* returns (i.e., the past 6 to 12 months) drive the decision to annuitize, consistent with a recency bias in belief extrapolation (Malmendier and Nagel, 2011).

When we regress mortality on the instrumented annuity decision, along with a rich set of control variables and fixed effects (birth-year and retirement-year), we find statistically and economically strong effects of annuities on mortality at the 5-year and 10-year horizons. Our estimates are comparable with other findings in the literature. For example, Dobbie and Song (2015) document that personal bankruptcy protection reduces 5-year mortality by 10.9% among individuals 60 and older, while we find that annuities reduce mortality by 2.55% over the same horizon.

Next, we discuss threats to our identification strategy and provide supporting evidence.

One potential concern about the exogeneity of our instrument is that returns could be correlated with the business cycle. The business cycle around retirement can influence long-term mortality either positively (Coile, Levine, and McKnight, 2014) or negatively (Finkelstein, Notowidigdo, Schilbach, and Zhang, 2024). We include retirement-year fixed effects in all of our specifications to control for the long-term influence of business cycles on mortality. In other words, we exploit *within-year* exposure to returns rather than broad fluctuations in returns that are potentially related to the business cycle.

Additionally, we conduct a placebo test to assess the extent to which the business cycle may affect our results and invalidate our IV strategy. We repeat our main analysis using fund returns immediately *after* retirement (e.g., over the following 6 months) and find no relationship between post-retirement returns and longevity. Since these future returns are temporally adjacent to the past returns used as our instrument, it is difficult to argue that macroeconomic conditions change abruptly and precisely at the date of retirement.

Furthermore, the exclusion restriction requires that pension fund returns affect mortality only through the annuity choice. Variations in pension fund returns can alter retirees' pension wealth, which in turn may directly influence mortality. To address this concern, we control for the pension balance at retirement in all our specifications. Moreover, wealth effects should be associated with lower mortality following good returns, whereas we find lower mortality following *poor* returns.

Another related concern is that individuals can choose when to retire. If fund returns influence the retirement decisions of individuals with unobserved traits that *also* correlate with mortality, then this selection might violate the exclusion restriction. To address potential endogeneity in retirement timing, we investigate annuity effects among individuals who retire at varying distances from the standard retirement ages set by law (60 for women, 65 for men). This analysis suggests that the annuity effects are robust

across retirees, regardless of their propensity to time their retirement around the standard age. This evidence indicates that strategic retirement timing is unlikely to drive our main findings.

Finally, we investigate the mechanisms behind the effect of annuities. We begin by examining heterogeneous effects across income levels to test whether annuities increase longevity by preventing retirees from running out of money. We then exploit heterogeneity in post-retirement return differentials between annuities and PW to assess whether annuities protect retirees from uncertainty and stress associated with market fluctuations. We draw on data from the CASEN survey to assess whether annuities promote health investments and improved health outcomes in retirement. We find evidence consistent with the latter two channels. The annuity effect is stronger among retirees who experience adverse return realizations early in retirement. Survey evidence further suggests that annuitants invest more in health (e.g., they receive more preventive care visits) and report lower disability rates later in life.

This paper contributes to three strands of literature. The first strand investigates adverse selection in annuity markets. Prior studies suggest that individuals act on private information about their longevity. For example, Finkelstein and Poterba (2004) documents that in the UK, individuals who live longer choose back-loaded annuities. Recent evidence on subjective survival beliefs, however, challenges this interpretation. Using data from the English Longitudinal Study of Ageing (ELSA), O'Dea and Sturrock (2023) show that individuals underestimate their longevity. Similarly, Heimer, Myrseth, and Schoenle (2019) find that individuals exhibit survival pessimism well into their 60s. How can retirees systematically underestimate their life expectancy yet sort into annuity contracts in ways consistent with realized mortality outcomes? Our findings suggest that annuities directly influence longevity, reconciling these otherwise contradictory results.

A second strand focuses on the reasons behind the annuity puzzle—a puzzle our findings suggest is even deeper than previously recognized. Prior work has proposed a variety of rational explanations—bequest motives, precautionary savings, adverse selection, fees, and intra-family longevity hedging (for a review, see Brown 2007). Additionally, researchers have proposed behavioral explanations such as framing, trend-chasing, present-biased preferences, and regret aversion (for a review, see Benartzi, Previtero, and Thaler 2011). We contribute to this literature by documenting that annuities could shape both health and longevity. If annuities causally improve longevity, they are more valuable than previously estimated, making the annuity puzzle even starker. These findings also bear on the pricing of annuities in private insurance markets (Koijen and Yogo, 2023).

A third, broader strand examines how economic conditions affect longevity. Several studies link recessions and financial crises to mortality (see Ruhm 2016, Coile, Levine, and McKnight 2014, and Finkelstein, Notowidigdo, Schilbach, and Zhang 2024). Other research connects financial shocks to individual health and mortality: Sullivan and von Wachter (2009b) find that displaced workers experience persistently higher mortality, Dobbie and Song (2015) document that bankruptcy protection reduces mortality, and Engelberg and Parsons (2016) show that stock market downturns have negative effects on individual health. We contribute to this literature by showing that the retirement payout choice—specifically, annuitization—improves retirees' health and longevity. These findings have implications for the design of payout options in employer-sponsored and private pension plans, and highlight the potentially negative welfare consequences of declining annuitization for retirees.

2 The Pension System in Chile

2.1 Pension Plans

A private defined-contribution (DC) system replaced the public pay-as-you-go system in 1980. All Chilean workers contribute 10% of their monthly taxable income to individual retirement accounts managed by pension fund administrators. A single type of pension fund (later labeled fund C) was available between 1980 and 2002. Since 2002, individuals have chosen between five types of funds (labeled A through E) with different risk profiles. Fund A has the highest share of equity, up to 80% of the portfolio, while fund E is almost entirely invested in domestic fixed-income securities.

2.2 Retirement Choices in the Chilean System

Given the start in 1980, there are already many retirees from the Chilean pension system. The standard retirement age is 60 for women and 65 for men. Most people retire at the standard age or shortly thereafter, as seen in Figure 1. We label old-age retirees those women and men who retire after 60 and 65, respectively. Individuals can retire earlier than the standard age under two conditions: (i) having sufficient funds to obtain a pension above 70% of the average wage received in the last 10 years, and (ii) that the first monthly pension is at least UF12 (around USD1,050).[1] In practice, individuals who qualify for early retirement are in their late 50s and early 60s.[2]

[1]The Chilean UF is an inflation-adjusted unit of account used for most financial contracts in the country (e.g., mortgages, leasing, college tuition, etc.). For our calculations, we use a conversion rate of UF1 = 37,015 Chilean pesos (CLP), and then adjust for purchasing power using USD1 = CLP426 according to the OECD. For comparison purposes, consider that the monthly legal minimum wage in Chile increased from UF6.56 in 2002 to UF11.39 in 2022.

[2]In addition to old-age and early retirement, individuals may retire if they are declared fully or partially disabled by a medical committee of the pension regulator.

Insert Figure 1 here

All retirees can choose among three payout mechanisms: an annuity, a phased withdrawal (PW), or a combination of the previous two. In the first case, the retiree uses her pension balance to purchase an annuity from an insurance company. The insurance company must pay the retiree an inflation-adjusted (otherwise fixed) amount per month until death. Annuity payments can start immediately or be deferred for some years. Annuities can also have a guaranteed period of payments (e.g., 20 or 30 years) to beneficiaries if the annuitant dies. The annuity decision is irreversible. For our analysis, we group all annuities together, since in all cases the longevity risk is transferred to the insurance company.

Under PW, the pension fund administrator pays the retiree out of her individual capitalization account. Retirees under PW are exposed to annual fluctuations in their portfolio returns. Retirees may allocate their money among funds C, D, and E, but they may not select the riskier funds (A or B). The payment amount under PW is reset annually according to rules and parameters set by the pension regulator. The individual has no flexibility as to how much to withdraw. In particular, payout under PW is equal to the balance in the individual retirement account at the end of the previous year divided by the NUC or Necessary Unit of Capital, which is given by the following formula:[3]

$$NUC = \sum_{n=age}^{110} \frac{l(n, age, gender, beneficiaries)}{(1 + r_{pw})^{n-age}} \tag{1}$$

The NUC is the present value of one unit of annual pension, taking into account the likelihood of survival ($l(.)$) and future returns (r_{pw}). Survival probabilities are a function of age and gender and account for beneficiaries. The probability of being alive at 110 is

[3]Annual payout under PW is paid in 12 equal monthly installments.

assumed to be zero. Future returns are assumed to be constant.

PW is reversible, and retirees may switch to annuities at a later date. Beneficiaries of a retiree under PW receive any balance left after her death. A final possibility is a combination of PW and annuity. The annuity amount, in this case, must be larger than the state-funded basic pension. We exclude retirees with a mix of PW and annuity from our analysis, although these cases are rare (less than 0.5% of all retirees in our sample).

2.3 The SCOMP Exchange

Since 2004, the choice between annuities and PW has been implemented through an exchange called SCOMP (Sistema de Consultas y Ofertas de Montos de Pensión). Through SCOMP, retirees receive offers for various annuity and PW contracts. The top of Figure 2 shows an example of the first-year monthly payment in PW contracts offered by different pension fund administrators. Fees are the only difference between offers, since the other parameters are set by the regulator. The graph at the bottom of Figure 2 shows a simulation of future PW payments.

Insert Figure 2 here

The purpose of the SCOMP exchange is to increase market transparency by reducing information asymmetries between retirees and insurance companies. Access to SCOMP is limited to individuals with pension savings sufficient to purchase a monthly annuity of at least UF3 (approximately USD 250). For those above UF3, SCOMP is compulsory. For those without access to SCOMP, PW is the only option, although they also receive government supplements. Sales agents from insurance companies and financial advisors help retirees access SCOMP and charge fees that are tilted toward recommending annuities (Boehm, 2024).

Our main dataset comprises all retirees who accepted an offer (annuity or PW) from the SCOMP exchange during 2004-2022. Table 1 shows averages of different variables for our sample of 591,909 retirees with complete data. Almost two-thirds of retirees choose annuities. The average value of the annuity purchased at retirement, or the initial balance under PW, is UF2,600, approximately USD225,000. The monthly payment during the first year is on average UF16.3. The mean (median) ratio of this initial payment to the individual's last pre-retirement income is 93% (59%), indicating a relatively high replacement rate in this sample. Individuals retire, on average, at age 63 after saving for more than 26 years. There are more men (66%) than women (34%) in our sample because the SCOMP database is biased toward higher-income individuals. The deceased represent 8% of the sample and their average age of death is 68.6 years. This average lifetime exceeds the life expectancy at birth for Chilean cohorts in the 1950s and 1960s, which was below 65 years.

Insert Table 1 here

3 Empirical Design

3.1 Main Regression

We are interested in estimating the effect of annuities on mortality. A starting point is the following OLS regression, which mimics Dobbie and Song (2015)'s study of the impact of bankruptcy protection on mortality:

$$Dead_{i,t+j} = \beta Annuity_{i,t} + \Gamma' X_{i,t} + \Omega_{i,t} + \epsilon_{i,t+j} \tag{2}$$

The variable $Dead_{i,t+j}$ equals one if the individual i, who retired at time t, has died

by year $t + j$ or earlier, and zero otherwise. We form a panel in which each individual is present for $j = T$ years, where T is 5 or 10. The panel is truncated for retirees for whom we do not observe the full T years because our sample ends (e.g., we observe an individual who retires in 2020 only up to 2022). We can estimate a different β for each post-retirement period j, although this is not shown in equation 2 for simplicity.

This approach to studying mortality has several advantages over alternative specifications. It allows us to include all retirees, regardless of whether they are deceased. Conditioning on death would significantly reduce our sample size and place disproportionate weight on earlier cohorts that naturally have more deaths. Relative to purely cross-sectional analyses, our framework also accounts for the timing of death within fixed horizons (five or ten years). For example, a purely cross-sectional approach at the end of ten years ($T = 10$) treats a retiree who dies in year $j = 2$ the same as one who dies in year $j = 9$. In contrast, our specification exploits the additional information provided by the later retiree's longer lifespan. The linear structure of Equation 2, in contrast to nonlinear duration models, facilitates the use of instrumental variables (see discussion in Palmer 2023). Our specification retains the flexibility of the linear probability model while incorporating the hazard-rate intuition of nonlinear duration approaches. This structure also allows for direct comparison of effect magnitudes with related studies on financial choices and mortality, such as Dobbie and Song (2015).

We are interested in estimating the coefficient β, which captures the effect of retiring with an annuity (rather than PW) on future mortality. The magnitude of β corresponds to the effect on average mortality rates over the horizon T. An alternative way to interpret β is that it captures the fraction of years gained (or lost) over the horizon T. For example, consider a sample with two retirees and $T = 10$: an annuitant who is still alive after ten years, and a PW-retiree who died at the end of year eight. The annuitant lives for two

more years out of ten, and, therefore, there is 20% lower mortality for annuitants in this sample ($\beta = -20\%$).[4]

The vector $X_{i,t}$ includes continuous variables measured at retirement for each individual: accumulated pension savings, last monthly income before retirement, and the number of years with contributions to the individual retirement account. Differences in observable characteristics between annuitants and PW retirees suggest that these control variables are necessary to estimate a clean effect of annuities on mortality. As seen in the last column of Table 1, annuitants retire with larger balances, receive larger initial payments, and have higher replacement rates than retirees with PWs. This evidence reflects annuitants' higher pre-retirement income (as in Finkelstein and Poterba 2002). Because high-income individuals live longer, on average, we would expect annuities to reduce mortality if we do not control for these characteristics.

The set of fixed effects $\Omega_{i,t}$ includes dummy variables for each type of retirement (old-age, early, and disability), retirement month dummies for seasonal effects (i.e., January, February, etc.), and, more importantly, birth-year and retirement-year fixed effects interacted with gender dummies. Hence, a woman born in 1950 and who retired in 2010 has a different fixed effect from a man born in 1950, and different fixed effects from a woman born in 1950 but who retired in 2011. Birth-year effects control for cohort differences in life expectancy. Life expectancy in Chile has increased from 55 years for those born in the 1950s to 80 years for those born in the 2020s.

Retirement-year dummies control for business-cycle effects on future mortality, as documented by Coile, Levine, and McKnight (2014) and Finkelstein, Notowidigdo, Schilbach,

[4]Since the panel structure is linear, life years are treated the same irrespective of who gets to live longer: 10 more years for one person are the same as one more year for 10 people. For example, imagine a single cross-section (i.e., $T = 1$) in which three out of 10 (30%) annuitants are dead, and five out of 10 (50%) PW-retirees are dead. In this case, we also obtain a regression estimate of $\beta = 30\% - 50\% = -20\%$.

and Zhang (2024). Variation in retirement age around the standard ages of 60 for women and 65 for men (see Figure 1) gives us power to disentangle birth-year (i.e., cohort) and retirement-year fixed effects. We cluster standard errors at the birth-year level.

Even after controlling for observable characteristics, omitted variables could still bias our OLS estimates of β. This bias makes it unlikely that our estimates capture the causal effect of annuities on mortality. For example, we do not observe individual private information on longevity expectations. Individuals who expect to live longer might be more likely to choose an annuity, leading to adverse selection and an overstatement of our estimates of β. Consistent with the role of adverse selection, Finkelstein and Poterba (2004) document that UK individuals who live longer take annuities with back-loaded payments and without guarantees.

Turning to the Chilean pension system, evidence about adverse selection is less straightforward. Consistent with annuitants having private information, Illanes and Padi (2019) study a sample of women without beneficiaries and find that annuitants, compared to non-annuitants, are less likely to die within two years after retirement. Boehm (2024) complements this evidence by studying the role of financial intermediaries in retirees' payout decisions in the SCOMP system. Specifically, intermediaries have financial incentives to steer clients toward annuities to maximize their commissions. Boehm (2024) documents adverse selection in the two years after retirement only among unadvised annuitants. The lack of adverse selection among advised annuitants suggests that intermediaries respond to their financial incentives by steering shorter-lived individuals toward annuities. Since more than 60% of Chilean retirees in SCOMP rely on financial intermediaries, these incentives may reduce adverse selection and might even produce advantageous selection.

3.2 IV Strategy

Because annuitization is an irreversible decision, a field experiment is infeasible. We therefore use an instrumental variable approach to identify the causal effects of annuities on mortality.

We use as instrument the pension fund returns in the six months before retirement. For example, if someone retires in July of 2010, our instrument is the return for the period from January 1st, 2010, to June 30th, 2010. We focus on fund C, the largest and oldest of the five funds available. As a moderate portfolio (40% equity and 60% fixed income), fund C is representative of the returns experienced by investors near retirement.[5]

Our choice of instrument is motivated by previous research showing that the demand for annuities is inversely related to past stock returns. Chalmers and Reuter (2012) and Previtero (2014) document this negative relationship for U.S. retirees. Figure 3 shows that there is a similar relationship among Chilean retirees. There is significant time-series variation in the aggregate annuitization rate and the returns of fund C. The annuity take-up steadily increases from a low point of 51% in early 2007 to a peak of 86% in January 2009 during the Great Recession. Then it falls to 43% in December 2010, following strong returns in the aftermath of the recession. During the rest of the 2010's, there is also a clear inverse relationship between returns and annuitization. The overall correlation between the two series is strongly negative (-0.51). The standard explanation for this inverse relationship in the literature is that retirees extrapolate future returns from past returns (Previtero 2014).

Insert Figure 3 here

[5]For retirees with PWs, fund C is the riskiest option available as investments in funds A and B are not permitted.

The first stage of the IV setup is:

$$Annuity_{i,t} = \lambda Returns_{i,t-6-t-1} + \Psi' X_{i,t} + \Omega_{i,t} + \upsilon_{i,t} \tag{3}$$

The retirement-year fixed effects absorb annual variation in $Returns_{i,t-6-t-1}$; thus, the relevant variation in our instrument is within year. The instrument retains within-year variation; for example, an individual who retires in December is exposed to returns that share only one of the six months with those faced by someone who retires in July of the same year. Given the preliminary evidence in Figure 3, we expect to find a negative λ in Equation 3, but this is not guaranteed since the figure uses raw data before year fixed effects are taken into account. With the predicted value $\widehat{Annuity}_{i,t}$, we can run the second stage of the IV setup:

$$Dead_{i,t+j} = \beta \widehat{Annuity}_{i,t} + \Gamma' X_{i,t} + \Omega_{i,t} + \nu_{i,t+j} \tag{4}$$

From the discussion above about potential biases in OLS, we expect to find $\beta_{OLS} \neq \beta_{IV}$. The IV estimate for β corresponds to the causal effect of annuities on mortality, if the IV assumptions hold.

The intuition behind our identifying assumption is that pension fund returns in the *few months* before retirement affect mortality *several years later* only through annuitization decisions, and that no omitted variables affect both recent pension fund returns and longevity. Next, we examine the IV assumptions in our setting. We start by introducing a covariate balance test for our instrument. Then we discuss potential threats to our IV approach.

3.3 Covariate Balance Test

In Table 2, we present a covariate balance test for our instrument, the pension fund C returns. In practice, we present summary statistics for individuals who retire after returns that are above or below the sample median of fund C's six-month returns. Except for fund returns, which differ by construction, we find no significant differences in other observable characteristics between the two samples. For example, individuals who retire after high returns have higher average balances (UF2,627) than those who retire after low returns (UF2,574). However, this difference is not statistically significant and is economically smaller than the difference in pension balances between annuitants and retirees who choose PW (see Table 1). Overall, this evidence is consistent with our instrument being as if randomly assigned.

Insert Table 2 here

Even if observable characteristics are balanced, this does not ensure that unobservable characteristics are also balanced by the instrument. These unobservable characteristics can influence both the decision to retire following good or bad returns and longevity. Thus, selection, rather than the annuity treatment itself, might explain the annuity effect on longevity.

3.4 Threats to the IV Strategy

Our IV identifies the effect of annuitization by exploiting variation in returns in the months immediately preceding retirement. Because retirement-year and birth-year fixed effects capture business-cycle and cohort conditions, respectively, identification comes from differences in exposure to pre-retirement returns that are driven by the timing of retirement within the calendar year and birth cohort.

In this setup, heterogeneity in underlying traits (wealth, risk preferences, financial sophistication, baseline health, etc.) does not, by itself, invalidate our IV strategy. Traits may determine who is a complier (i.e., individuals whose retirement choice is sensitive to pre-retirement returns), but without contaminating the IV setup. The IV estimation relies on comparisons between annuitants and non-annuitants *among* the compliers. Our IV approach is threatened only if returns differentially shift heterogeneous types into annuitization versus PW—so that the "marginal annuitant" under low returns and the "marginal non-annuitant" under high returns differ in latent mortality risk for reasons unrelated to the annuity choice.

Risk aversion provides a useful illustration of what a violation of the exclusion restriction would require. Risk-averse retirees may be more inclined to annuitize and may also have lower mortality risk due to safer behavior. This average correlation alone does not invalidate our IV approach. A violation would require a stronger, return-contingent selection pattern operating within retirement years and birth cohorts: poor returns would need to disproportionately induce more risk-averse individuals to retire, while, *within the same year and cohort*, good returns would need to disproportionately induce less risk-averse individuals (more prone to take PW) to retire. In such a case, marginal annuitants would be more risk-averse and marginal non-annuitants would be less risk-averse, and our instrument would reflect a selection effect—different risk preferences among those who retire after good and bad returns—rather than the causal effect of annuitization. We provide supporting evidence for the independence of our instrument and the exclusion restriction in subsection 4.5.

4 Do Annuities Reduce Mortality?

4.1 Baseline Results

Table 3 presents the main results for horizons (T) of five and ten years. For each horizon under consideration, we show the OLS regression (Equation 2), the reduced-form regression of $Dead_{i,t+j}$ directly on the instrument $Returns_{i,t-6-t-1}$, the first-stage regression (Equation 3), and the second-stage regression (Equation 4) of the IV setup.

Insert Table 3 here

The variable $Dead_{i,t+j}$ is multiplied by 100, so the coefficients can be interpreted as percentage points. The negative OLS coefficient in column 1 implies that annuitants have a 0.69% (0.87%) lower mortality rate over the next 5 (10) years.

The positive reduced-form coefficient (column 2) indicates that retirees with positive pre-retirement fund returns have higher mortality. A one-standard-deviation shock to returns (4.9%) implies a 0.07% (0.08%) higher mortality at the 5-year (10-year) horizon. The effects are economically small, but strongly significant. The reduced-form regression is inconsistent with a mechanical wealth effect of returns, whereby individuals retire with larger pension balances after high returns. Since higher wealth is negatively associated with mortality, we would expect negative rather than positive coefficients for returns.

The first-stage coefficient estimates the relation between fund returns and the annuitization decision. The coefficient of -0.55 (in column 3, Panel A) implies that a one-standard-deviation increase in returns reduces the likelihood of taking annuities by 2.7% ($-0.55 \times 4.9\%$). The unconditional annuitization rate is 66%, so the effect may appear small; however, we are already partialling out a substantial fraction of the variation in annuitization through control variables and fixed effects. The Kleibergen-Paap robust

F-test for the first stage regression is equal to 69.8, comfortably above the threshold of 10, alleviating concerns about a weak instrument problem.[6]

The second-stage coefficient shows a negative effect of annuities on mortality (column 4). Mortality is reduced by 2.55% at the 5-year horizon, and 3.62% at the 10-year horizon. These effects are not statistically different from each other.

4.2 The Magnitude of the IV Estimates

Our estimates of the effect of annuitization on mortality are plausible relative to those in the literature. For instance, our estimates are smaller than the mortality difference between annuitants and non-annuitants in other settings. Using U.K. data, Finkelstein and Poterba (2002) report that the cumulative mortality rate from ages 65 to 82 for a voluntary male annuitant is 15% lower than that of the average male, which provides a rough upper bound for our estimates.[7] Our panel estimate reflects the average difference in cumulative mortality rates during the first T years after retirement. As such, it should be smaller than the difference in cumulative mortality at age 82. Moreover, the estimates in Finkelstein and Poterba (2002) combine both selection and treatment effects, while ours arguably capture only the treatment effect.

Turning to research on financial decisions and mortality, Dobbie and Song (2015) find that bankruptcy protection for Americans who file at age 60 or older reduces five-year mortality by 10.9%—an effect three times larger than the annuity effect in our study. This stronger impact may reflect that elderly bankruptcy filers constitute a highly selected sample of the population and that these individuals often experience elevated stress levels

[6] When there is one endogenous regressor and one instrument, the Kleibergen-Paap F-statistic is numerically equivalent to the Montiel-Olea and Pflueger effective F-statistic (Andrews, Stock, and Sun, 2019).

[7] Finkelstein and Poterba (2002) report cumulative survival probabilities, which are simply one minus the cumulative mortality rate that we report above.

before filing.

The IV coefficient for $Annuity_{i,t}$ is larger (in magnitude) than the OLS coefficient. This situation is common in IV setups (see Jiang 2017, and Pancost and Schaller 2025). The standard explanation is that selection effects (i.e., omitted variables) account for the difference between OLS and IV.[8] In the case of annuities, the literature typically finds evidence consistent with adverse selection (e.g., Finkelstein and Poterba 2004), whereby individuals who expect to live longer are more likely to choose annuities. Thus, the OLS coefficient should be larger than the IV coefficient.

Instead, our estimates are more consistent with advantageous selection—that is, people who are less likely to live longer select into annuities. Institutional features of the Chilean pension system can account for this type of selection. Boehm (2024) documents that financial intermediaries are prevalent in SCOMP payout decisions and that they have financial incentives to sell annuities. Moreover, Boehm (2024) finds evidence consistent with intermediaries steering some shorter-lived retirees toward annuities. If less sophisticated and poorer individuals—who also have lower life expectancy—are more likely to follow advisors' recommendations, then intermediaries' influence can lead to advantageous selection.

We investigate further the difference between OLS and IV estimates in different retiree sub-samples in Table A3. Consistent with Boehm (2024), we find evidence that suggests advantageous selection—that is, OLS estimates understating the annuity effect—for the subsample of advised retirees (columns 1 vs. 2). In contrast, we find evidence of adverse selection—OLS estimates overstating the annuity effect—for the subsample of unadvised retirees (columns 3 vs. 4). We also study the difference in annuity effects by gender (two-

[8] In addition to omitted variables, measurement error and heterogeneous treatment effects can also contribute to differences between OLS and IV estimates (Pancost and Schaller, 2025).

thirds of our overall sample are men). Similar to Illanes and Padi (2019), we find evidence consistent with OLS overstating the annuity effect, and hence with adverse selection, in women (see columns 5 vs. 6), but not in men (columns 7 vs. 8).

4.3 Robustness Tests

In Figure 4, we show the second-stage coefficients for the year-by-year estimation in the post-retirement period. The regression specification otherwise matches that of our baseline model.

We find that the point estimates of the effect of annuities on mortality increase over time. In particular, after year 5, the effect roughly doubles in magnitude. The estimates are still smaller than the differences between annuitants and non-annuitants reported in Finkelstein and Poterba (2002). In part because of the smaller sample size for each regression, the effects are noisier than in the panel specification. Thus, we cannot reject the null hypothesis that the coefficients across the post-retirement years are equal. Overall, this evidence suggests that annuities affect both short- and long-term mortality.

Insert Figure 4 here

In Table 4, we present the reduced-form and second-stage results for 10-year mortality using returns at various horizons *before* retirement. Returns for months $t-12$ through $t-1$ before retirement yield mortality increases similar to those from returns in the months $t-6$ through $t-1$. The second-stage coefficient for $Annuity_{i,t}$ is approximately twice as large with 12-month returns (-7.22 vs. -3.62) and is strongly significant. The 3-month returns do not predict future mortality in the reduced form. Analogously, we estimate a smaller, insignificant coefficient for $Annuity_{i,t}$ in the second-stage regression when using the 3-month return as an instrument.

Longer return horizons, between months $t-36$ and $t-1$ or $t-24$ and $t-1$, also have little predictive power, both in reduced form and in the second-stage regressions. This evidence implies that retirees rely more on recent returns when making their annuitization decisions (as in Previtero 2014). This finding fits well with the recency bias in return extrapolation (Greenwood and Shleifer, 2014), whereby investors extrapolate recent instead of long-dated returns into the future.[9]

Insert Table 4 here

4.4 Analysis of Compliers

Our IV strategy identifies the annuity effects from compliers, individuals whose pension choices change in response to our instrument, i.e., past pension fund returns. Compliers are individuals at the margin, or for whom the costs and benefits of the two payout options are close enough so that a change in returns tips the decision one way or the other. In this subsection, we aim to characterize compliers to better assess the external validity of our findings. In fact, it can be shown that β_{IV} is the local average treatment effect (LATE) for the complier population, which may differ from the population-level treatment effect.

In our setting, compliers are more likely to choose annuities when past returns are low and less likely when past returns are high. Extrapolative beliefs are the leading explanation in the literature for this inverse relation between past returns and annuitization (Previtero 2014). Simply put, individuals believe that good or bad returns will continue into the future. Therefore, retirees are more reluctant to accept fixed-income products, such as annuities, after experiencing favorable market returns.

[9]Consistent with our findings, Malmendier and Nagel (2011) also document stronger effects of more recent returns on financial risk-taking.

Consistent with the prevalence of extrapolative beliefs among investors, Greenwood and Shleifer (2014) show that survey-based expectations of future stock returns are positively correlated with recent returns. Extrapolation may be particularly relevant for pension choices, as older individuals rely more heavily on rules of thumb when taking investment decisions (Besedeš, Deck, Sarangi, and Shor 2012).

Following Angrist and Pischke (2009), we study the prevalence of a characteristic in the complier population compared to the general population. We compute the ratio of the first-stage coefficient in a given subsample divided by the full-sample first-stage coefficient (from Table 3). Subsamples are defined using a categorical variable (e.g., men) or observations above the median of a continuous variable (e.g., pension balance). If the ratio of first-stage coefficients is above (below) one, then the compliers are more (less) likely to have that characteristic than the full sample.

Insert Table 5 here

Table 5 shows that compliers are significantly less likely to retire with large balances, many years of contributions, and with a high replacement rate. Pension savings are positively correlated with financial literacy (see Hastings and Mitchell 2020 for evidence in Chile). These findings are consistent with compliers being extrapolators as the tendency to extrapolate is stronger among less sophisticated investors (Da, Huang, and Jin 2021). Additionally, compliers are more likely to be older or to retire late, again suggesting that compliers might be extrapolators given the higher prevalence of extrapolation among older investors (Previtero, 2014). Lastly, compliers are more likely to employ financial advisors, suggesting that advisors themselves may share extrapolative beliefs (Linnainmaa, Melzer, and Previtero 2021), or that advisors may pander to their clients' biases (Gennaioli, Shleifer, and Vishny 2015).

Overall, our analysis shows that compliers share several characteristics with individuals more likely to hold extrapolative beliefs. This evidence has implications for the external validity of our findings. For example, to the extent that our compliers lack financial sophistication, our findings are less likely to apply to financially sophisticated populations.

4.5 Potential Violations of the Independence and Exclusion Restrictions

Identifying the causal impact of annuities on longevity is difficult because unobservable factors—such as risk aversion and private information about life expectancy—can affect both the decision to annuitize and longevity. Our instrumental variable approach allows us to focus solely on the relationship between annuitization and mortality. Given that we use as an instrument the pension fund returns in the six months before retirement, these returns are less likely to directly affect mortality several years later or to be correlated with other unobserved determinants of mortality.

One potential concern about the exogeneity of our instrument is that pension fund returns could correlate with the business cycle around retirement, which in turn coulc influence long-term mortality. Coile, Levine, and McKnight (2014) show that individuals approaching retirement during a recession are likely to experience long-lasting negative consequences and increased mortality due to higher unemployment and reduced access to health care.[10] We include retirement-year fixed effects in all specifications (Equation 3 and Equation 4) to control for business cycle effects on mortality. Fixed effects allow us to remain agnostic about the sign of the relationship between business cycles and longevity, which is relevant given recent evidence from Finkelstein, Notowidigdo, Schilbach, and

[10]This long-term effect is separate from the documented *contemporaneous* negative association between recessions and mortality (Ruhm, 2016).

Zhang (2024), who document that the Great Recession reduced long-term mortality in the U.S., contrary to prior evidence.

Additionally, we conduct a placebo test to assess the extent to which the business cycle may affect our results and invalidate the IV strategy. We repeat our main analysis using the fund returns immediately *after* retirement (e.g., the subsequent six months). Because these returns occur after retirement, they cannot, by construction, affect the already fixed pension choice. Any influence of future returns on mortality could be consistent with omitted variables. Conversely, the absence of a relationship between post-retirement returns and mortality would suggest that violations of the independence of our instrument are less likely. Since these future returns are adjacent to the returns in our instrument, it is hard to argue that the influence of any macroeconomic variable would suddenly disappear right after the date of retirement.

Insert Table 6 here

In Table 6, we present the reduced-form and second-stage results for 10-year mortality using returns *after* the retirement date. The reduced-form regressions indicate no significant association between post-retirement returns at various horizons—months $t+1$ up to $t+36$—and mortality. Similarly, in the second-stage regressions, we find no statistically significant effect of annuities on mortality, and the sign even reverses compared to our baseline results. This evidence supports the independence of our instrument. If, in fact, returns reflect the business cycle effects on mortality, we should not expect the effect to disappear or reverse *immediately* after the retirement date.

The exclusion restriction requires that pension fund returns affect mortality only through the annuity choice. Variation in returns can alter retirees' pension wealth, which in turn may directly influence mortality. This concern is unlikely to be relevant in our

setting. First, we control in all our specifications for the pension account balance at retirement. Second, wealth effects should be associated with lower mortality following good returns, whereas we predict lower mortality following poor returns (through higher annuity take-up). This latter consideration also helps mitigate concerns about unobserved external wealth or stress related to fluctuations in returns. Following good returns, retirees should experience increased financial wealth and lower stress levels. Both of these elements should predict lower—and not higher—mortality.

A related concern is that individuals choose when to retire. If returns influence the retirement decisions of individuals with unobserved traits that *also* correlate with mortality, then this selection might violate the exclusion restriction. For instance, poor returns could induce risk-averse individuals to retire earlier. If risk-averse individuals adopt more prudent behavior and live longer, then selection—rather than treatment—could explain our findings.

Descriptive evidence from Table 2 suggests that retirees following high and low returns have similar (observable) demographic characteristics. Moreover, the average number of retirees is similar across return sub-samples (2,751 vs. 2,755). Nonetheless, we cannot rule out the possibility that the composition of retirees might change along unobservable dimensions.

Insert Figure 5 here

We address the issue of endogenous retirement timing by examining subsamples of individuals who retire within a specified window around the standard retirement ages of 60 for women and 65 for men. Our intuition is that women (men) retiring closer to 60(65) are less likely to strategically time their retirement. We set windows from $\pm$ 1 to $\pm$ 5 years around the standard retirement age. As seen in Figure 5, the effects of annuities are

not statistically different between individuals retiring close to or far from the standard retirement age. In other words, strategic retirement does not appear to drive our results.[11]

As an additional robustness check, we investigate the annuity effect for individuals who retire in their birth month relative to any other month. The intuition behind this analysis is that retirees who follow heuristics, such as retiring around their birthday, are less likely to time their retirement strategically. This analysis more closely approximates an ideal experiment in which retirement is mandated at specific ages, and our instrument captures exogenous variation in pension fund returns in the six months before a retiree's birthday. We report the results of our IV estimates for these subsamples in the Appendix, in Table A4. Point estimates of the annuity effects are comparable between individuals who retire in their birth month or quarter and those who retire in any other month or quarter. The estimates across these subsamples are not statistically different at conventional significance levels.

Overall, our analysis suggests that the annuity effect is robust across retirees, regardless of whether they are more or less likely to time their retirement. Although we cannot rule out all potential violations of the independence and exclusion restrictions, the above considerations impose nontrivial constraints on the nature of the selection or on omitted variables that could invalidate our IV strategy.

5 Why do annuities reduce mortality?

Because payments are adjusted for inflation, annuities provide a constant stream of income in terms of purchasing power. Phased withdrawals (PW), by contrast, provide income

[11] We omit from Figure 5 individuals who retire exactly at the legal age (i.e., $\pm$ 0 years) because the residual variation in the instrument after birth-year and retirement-year fixed effects is much smaller than in the full sample, leading to predictably smaller and noisier estimates.

that is likely to decline later in life (Figure 2), for instance, to account for declining survival probabilities in the population (see Equation 1). Retirement income under PW also depends on pension fund returns: income may increase when returns are high, and it may decline faster than initially anticipated when returns are low. We study three non-mutually exclusive channels through which annuities may affect longevity relative to PW. We assess whether the effect of annuities comes from preventing retirees from running out of money. Next, we study whether annuities protect retirees from the income uncertainty and stress associated with return fluctuations. Finally, we examine whether annuities promote health investments and overall better health in retirement.

5.1 Do annuities prevent retirees from running out of money?

Medical expenses typically increase later in life. Using data from the Health and Retirement Study, Fahle, McGarry, and Skinner (2016) show that out-of-pocket medical expenses rise sharply with age and even more near the end of life. Annuitants are less likely to run out of money when facing higher medical costs later in life.[12]

Low earnings increase mortality, as documented by (Sullivan and von Wachter, 2009a). If annuities prevent individuals from running out of money, we would expect their effect to be stronger among individuals with lower incomes and limited resources to cover health-care expenses. Controlling for post-retirement income in our regressions could generate a bad control problem (Angrist and Pischke 2009). Therefore, we estimate the main specification (Equation 4) separately for subsamples of retirees above and below the median post-retirement income.[13] To address the concern that some of the sample splits may

[12]Expected health costs can be a first-order determinant of the demand for annuities and portfolio choice. For a treatment of this topic, see De Nardi, French, and Jones (2010), Peijnenburg, Nijman, and Werker (2017), and Yogo (2016).

[13]The post-retirement real income for annuitants is constant and equal to the first payment. For retirees with PW, we compute post-retirement real income using the Stata module `cnu` provided by the

themselves be endogenous to the payout choice, we repeat these analyses using the top and bottom quartiles of the same variables (post-retirement income, pension balance, and replacement rate). In Appendix Table A5, we find results similar to those presented here.

Insert Table 7 here

In Table 7 (columns 1 and 2), we find that the effect of annuities is not stronger in the low post-retirement income sample, which is contrary to the notion that running out of money drives the effect of annuities. If anything, our estimates are larger for the sample with high post-retirement income (-6.45) than for the sample with low post-retirement income (-0.71). While economically meaningful in magnitude, this difference is imprecisely estimated (p-value 10.4%).

We obtain qualitatively similar results when we split the sample by the pension balance at retirement or replacement rates (see columns 3-7). Taken together, the evidence shows that the effect of annuities on longevity is not limited to retirees with low income, low pension balances, or low pension replacement rates. The possibility that a non-annuitant runs out of money is unlikely to be the primary determinant of the effect of annuities in the high-income sample. It is worth noting that the SCOMP exchange excludes many low-income individuals, who are far more likely to run out of money in retirement. Hence, our sample is less likely, by construction, to showcase this channel.

5.2 Do annuities shield retirees from investment-related uncertainty?

Another possibility is that, even if PW retirees do not run out of money, PW exposes retirees to greater income volatility since payments fluctuate with the returns of pension

pension regulator, assuming the retiree selects fund C after retirement.

funds. The literature shows that negative income shocks can negatively affect longevity (Sullivan and von Wachter 2009b). Similarly, fluctuations in financial markets that affect retirement wealth can increase stress, decrease mental health, and ultimately lead to higher mortality (Engelberg and Parsons 2016, Schwandt 2018).

To address this possibility, in Table 8 we run our main specification splitting the sample by *post*-retirement returns. More specifically, we compute the one- or two-year return differential between the chosen payout form and the alternative (not chosen) option. Retirees experience "bad luck" if the ex-post return differential does not go in their favor: if they initially choose PW (annuity) and the ex-post return on pension funds negatively (positively) surprises compared to the annuity yield available to them at retirement.[14] "Good luck" is defined conversely.

The intuition behind our test is as follows. Annuitants—who receive a stable stream of income—are protected from bad luck. Non-annuitants are exposed to bad luck, and can suffer from the consequent lower income, or from stress and anxiety. Instead, when we compare samples of annuitants and non-annuitants who have good luck, the effect of annuities is likely to be muted: the income of PW retirees increases with the strong returns and the income of annuitants stays flat. Therefore, under the uncertainty hypothesis, we should find that the effect of annuities is concentrated among retirees who face bad luck.

Insert Table 8 here

We begin by defining good and bad luck according to the sample median of return differentials (columns 1 and 2 in Table 8). Consistent with the idea that annuities protect from poor returns and mitigate potential stress, our estimates are stronger when retirees

[14]For an annuitant, we compute the difference between the average yield on annuities in the month of retirement (say, July of 2010), and the return on pension fund C in the 12 or 24 months that follow (August 2010 to July 2011, or July 2012). Conversely, for a non-annuitant, we compute the differential between the ex-post returns of fund C and the annuity yield at the time of retirement.

face bad luck (−2.26) than when they face good luck (0.50). This difference is marginally statistically significant (p-value 9.8%). In columns 3 and 4, we vary the definition of bad luck as facing return differentials that are below the bottom quartile of the sample distribution. The difference in the annuity effect between the sample with good and bad luck becomes economically stronger (−4.01 vs. 0.04), and it is highly statistically significant (p-value 0.7%).

In columns 5 to 8 of Table 8, we repeat the analysis with return differentials computed in the two years after retirement. Consistent with the evidence in columns 1 to 4, we find stronger annuity effects for the bad-luck sample, with these differences economically and statistically significant, with p-value of 3.2% for the median split and 2.4% for the top-bottom quartile split.

Overall, this evidence shows that the effect of annuities is particularly strong when retirees face bad luck after retirement. We interpret these findings as consistent with annuities reducing uncertainty about future income and alleviating the stress and anxiety associated with poor financial returns.

5.3 Do annuities promote better health?

Last, we explore the idea that annuities reduce mortality by promoting better health. Annuities provide a stable stream of income that can help cover recurring expenses, such as medical insurance or health check-ups. In addition, annuities can provide stronger monetary incentives to live longer and healthier lives (Philipson and Becker 1998). By setting up life-contingent payments, annuities introduce a classical moral-hazard problem, whereby those insured do more of what they are insured against, in this case, living.[15]

[15]Consistent with this idea, the evidence in Table 7 suggests that the effect of annuities is stronger for retirees who face stronger financial incentives as proxied by higher post-retirement income or higher replacement rates.

Given that we do not observe health information in our main sample, we complement our analysis with data from the CASEN survey. CASEN is a repeated cross-sectional survey that reports, among other things, information on health and living standards for a representative sample of Chilean households.[16] More specifically, CASEN asks questions about health investments, such as whether respondents have complementary health insurance or have had a health check-up in the past 12 months. In addition, the survey includes questions about disabilities or difficulty with day-to-day activities such as eating, going to the bathroom, getting dressed, or going out of the house. Each response can go from 1 (no difficulty) to 5 (severe difficulty). We compute a variable, "Mean Disability," which is the average across the ten disability questions.

Questions regarding sources of retirement income, such as PW or annuities, start with the 2011 survey. For our analyses, we focus on retired women (men) aged 60 (65) and older who receive non-disability pension income from either PW or an annuity. Table A1 reports summary statistics for the CASEN sample.

Unlike in the SCOMP sample, we do not know the exact retirement date for CASEN respondents. However, we use the age at the time of survey responses to estimate when women (men) turned 60 (65). We use the 60th(65th) birthday as a noisy proxy for the actual retirement date, and we estimate our IV using returns over the six months preceding this pseudo-retirement date. Given that women (men) have the flexibility to retire before or after their 60th(65th) birthday (see Figure 1), we expect the estimates from the CASEN sample to be less precise than our main findings.

Insert Table 9 here

In column 1 of Table 9, we run the first stage of the IV setup in the CASEN sample.

[16]The CASEN survey provides information comparable to that of the US Health and Retirement Study.

Returns before the pseudo-retirement date are negatively associated with annuitization, as in our main specification in Table 3. Consistent with attenuation bias due to noise in the retirement date, we find that the coefficient for returns is less than half of that in the main sample.[17] Nonetheless, we do not seem to face a weak instrument problem since the first-stage F-statistic is equal to 11.05.

In columns 2 through 10, we present the OLS, reduced-form, and second-stage results for dependent variables related to health investments and health outcomes. We focus the discussion on the IV estimates. We begin by investigating the effects of annuities on the likelihood of purchasing complementary health insurance. While the point estimate is positive, the IV coefficient is noisily estimated and not statistically significant at conventional levels (p-value 35.3%). Next, we find that annuities increase the likelihood of having a health check-up in the last 12 months by 57.8 percentage points. This coefficient is marginally statistically significant (p-value of 9.7%). Similarly, annuities reduce the average disability by 0.79 points, or nearly 1.5 standard deviations of the disability measure in our sample. This coefficient is also marginally statistically significant (p-value of 6.7%).

Although our estimates are less precise than those in our main sample, the CASEN evidence is valuable for at least two reasons. First, it provides an out-of-sample validation of our main results from the SCOMP data, e.g., the inverse relationship between annuitization and past returns. Second, the CASEN evidence points to a mechanism that cannot be tested with the SCOMP data, namely, that annuities promote higher health investments and better health later in life.

[17] An important difference between our main SCOMP sample and the CASEN sample is that the latter most likely includes poor individuals who did not have access to SCOMP at retirement. Their only available option was PW. These are "never takers" in the IV setup since they cannot get the annuity "treatment" because of institutional constraints. This can also lead to attenuation in the first stage.

To assess the external validity of our findings in this section, we collect data on US retirees from 2002 to 2020 in the Health and Retirement Study (HRS).[18] In Table A2, we document that annuitants have higher health care expenses, are more satisfied with retirement, and have fewer depression and disability symptoms. We also find that annuitants in the HRS adopt healthier behavior: they are more likely to exercise, less likely to smoke, and have lower body weight. Unfortunately, in the HRS sample, there is insufficient retiree discretion in annuitization choices to apply our identification strategy based on stock market returns. With the caveat that differences in the HRS are also likely to reflect selection rather than annuity treatment effects, this evidence is at a minimum consistent with our findings on annuity effects on health investments and outcomes.

6 Conclusions

What is the relationship between annuities and longevity? By providing a stable income stream for as long as someone lives, annuities offer retirees a simple way to manage their finances later in life, when they face cognitive decline and high health expenses.

Using data from close to 600,000 Chilean retirees, we investigate whether annuities directly affect longevity. For identification, we rely on the fact that recent pension fund returns provide a plausibly exogenous shock to the propensity to annuitize. More specifically, our identifying assumption is that pension fund returns in the six months before someone's retirement (e.g., at 60 or 65) are unrelated to mortality several years later, except for their impact on the annuitization decision. Retirees take past returns into account for their decision most likely due to extrapolative beliefs. Our instrumental vari-

[18] We follow previous studies to identify annuitants (Panis 2004). For each individual, we compute the average response across surveys in which they appear. Then, we average across individuals with and without annuities.

able approach shows that annuities have a positive, economically meaningful impact on longevity.

Additional analysis highlights how annuities reduce mortality through two non-mutually exclusive channels. By providing a stable stream of income, annuities shield retirees from income uncertainty and the stress associated with market fluctuations. In fact, the annuity effects are stronger among retirees who experience bad luck in terms of ex-post returns. In addition, by providing life-contingent payments, annuities appear to promote health investment and, hence, better health and lower disability rates after retirement .

The evidence that annuities may have a direct effect on longevity, beyond the well-documented selection effects, has several implications. Understanding the treatment effect of annuities is important for the correct design of pension systems. Philipson and Becker (1998) highlight how introducing mandatory annuity programs such as Social Security was associated with a rapid rise in life expectancy at older ages, potentially due to the incentives provided by annuities. Many countries have reduced the generosity of annuitized public pensions and nudged citizens to rely more on private or employer-sponsored retirement plans that have a lower annuitized component. This trend could reverse the longevity gains achieved by the Social Security system. An additional consideration concerns the correct pricing of annuities. Insurance companies rely on annuitants' mortality projections to price annuities, assuming negligible annuity treatment effects. Incorporating these direct effects can improve the annuity pricing process (Koijen and Yogo, 2023). As the largest Baby Boomer cohort retires over the next few years, understanding the interplay between annuity selection and treatment effects can improve the welfare of millions of retirees.

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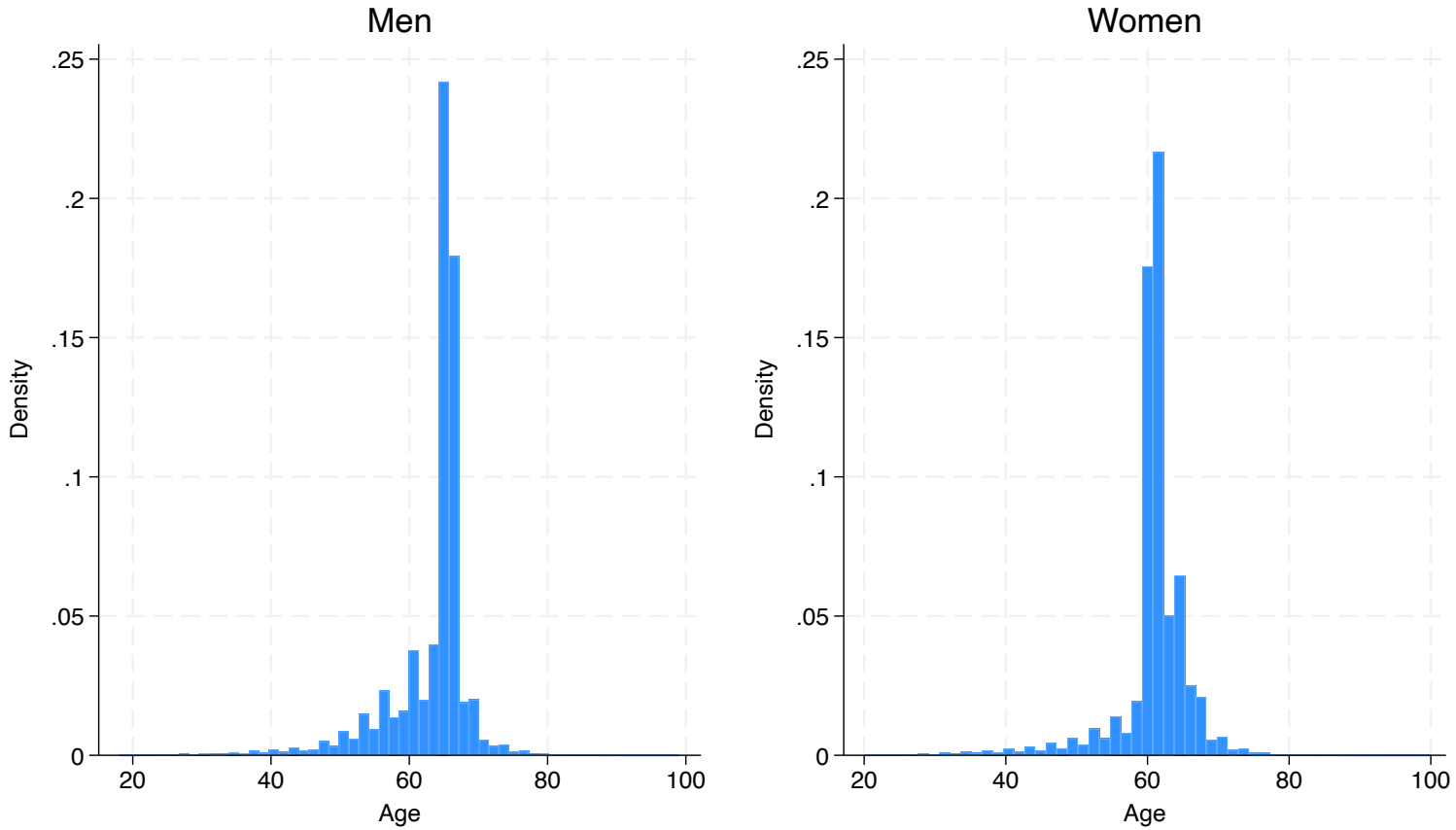
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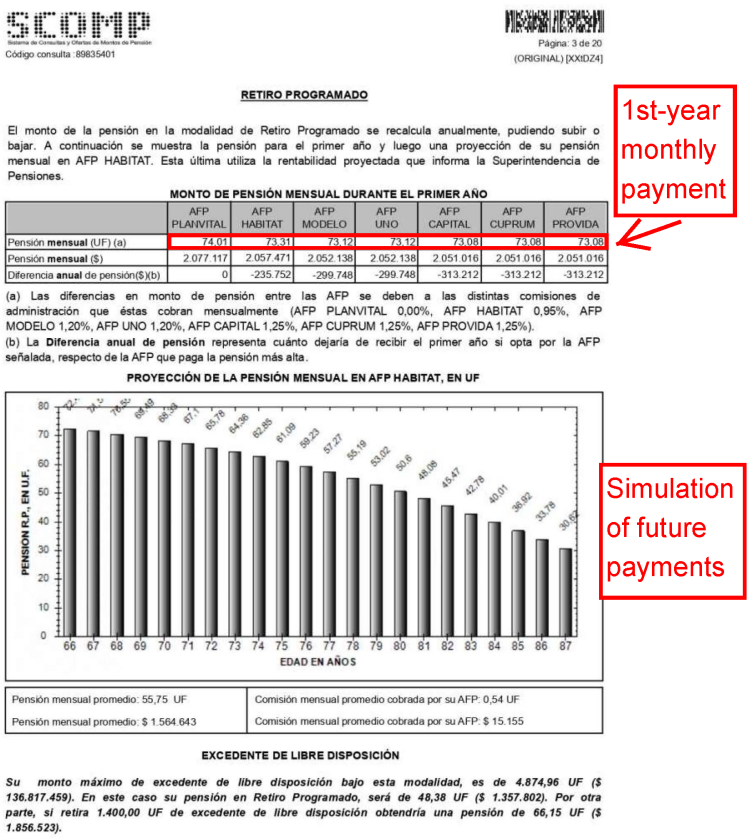
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Figure 1: Retirement Age in the Chilean Pension System



Notes: This figure shows the distribution of retirement ages for men (left panel) and women (right panel) in the Chilean pension system. Data are obtained from the SCOMP exchange. More details are reported in Table 1.

Figure 2: Offers of Phased Withdrawal from SCOMP



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Sistema de Consultas y Ofertas de Montos de Pensión
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RETIRO PROGRAMADO

El monto de la pensión en la modalidad de Retiro Programado se recalcula anualmente, pudiendo subir o bajar. A continuación se muestra la pensión para el primer año y luego una proyección de su pensión mensual en AFP HABITAT. Esta última utiliza la rentabilidad proyectada que informa la Superintendencia de Pensiones.

MONTO DE PENSIÓN MENSUAL DURANTE EL PRIMER AÑO

	AFP PLANVITAL	AFP HABITAT	AFP MODELO	AFP UNO	AFP CAPITAL	AFP CUPRUM	AFP PROVIDA
Pensión **mensual** (UF) (a)	74,01	73,31	73,12	73,12	73,08	73,08	73,08
Pensión **mensual** ($)	2.077.117	2.057.471	2.052.138	2.052.138	2.051.016	2.051.016	2.051.016
Diferencia **anual** de pensión($)(b)	0	-235.752	-299.748	-299.748	-313.212	-313.212	-313.212

(a) Las diferencias en monto de pensión entre las AFP se deben a las distintas comisiones de administración que éstas cobran mensualmente (AFP PLANVITAL 0,00%, AFP HABITAT 0,95%, AFP MODELO 1,20%, AFP UNO 1,20%, AFP CAPITAL 1,25%, AFP CUPRUM 1,25%, AFP PROVIDA 1,25%).
(b) La **Diferencia anual de pensión** representa cuánto dejaría de recibir el primer año si opta por la AFP señalada, respecto de la AFP que paga la pensión más alta.

PROYECCIÓN DE LA PENSIÓN MENSUAL EN AFP HABITAT, EN UF

Pensión mensual promedio: 55,75 UF	Comisión mensual promedio cobrada por su AFP: 0,54 UF
Pensión mensual promedio: $ 1.564.643	Comisión mensual promedio cobrada por su AFP: $ 15.155

EXCEDENTE DE LIBRE DISPOSICIÓN

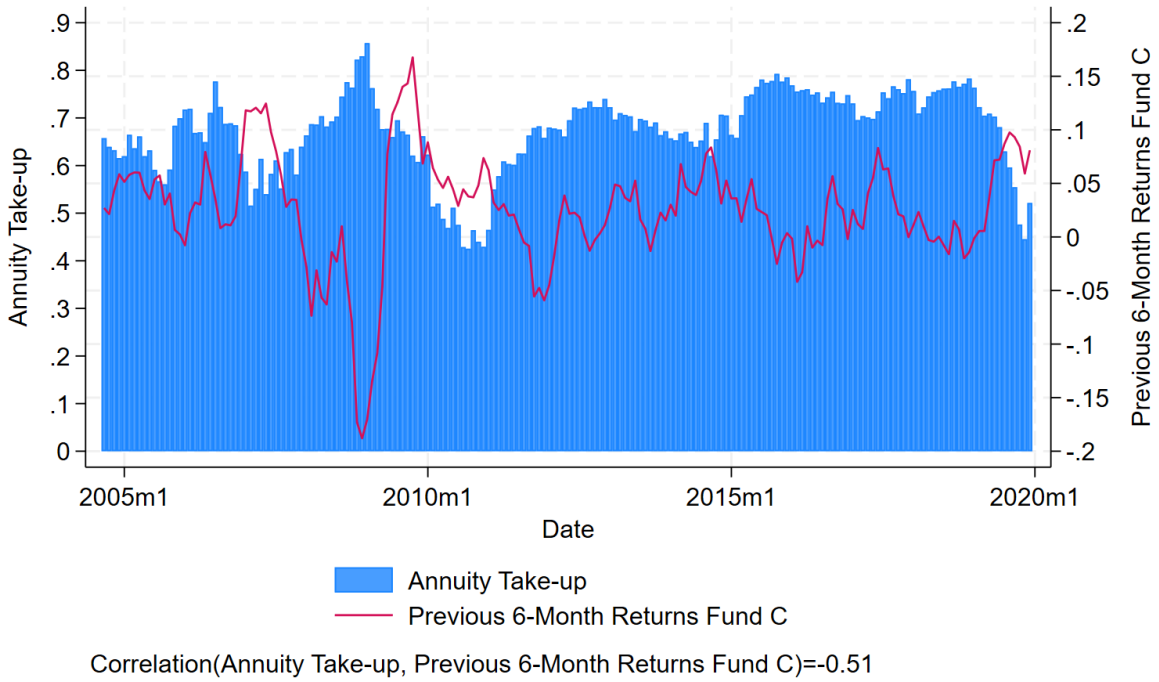
Su monto máximo de excedente de libre disposición bajo esta modalidad, es de 4.874,96 UF ($ 136.817.459). En este caso su pensión en Retiro Programado, será de 48,38 UF ($ 1.357.802). Por otra parte, si retira 1.400,00 UF de excedente de libre disposición obtendría una pensión de 66,15 UF ($ 1.856.523).

1st-year monthly payment

Simulation of future payments

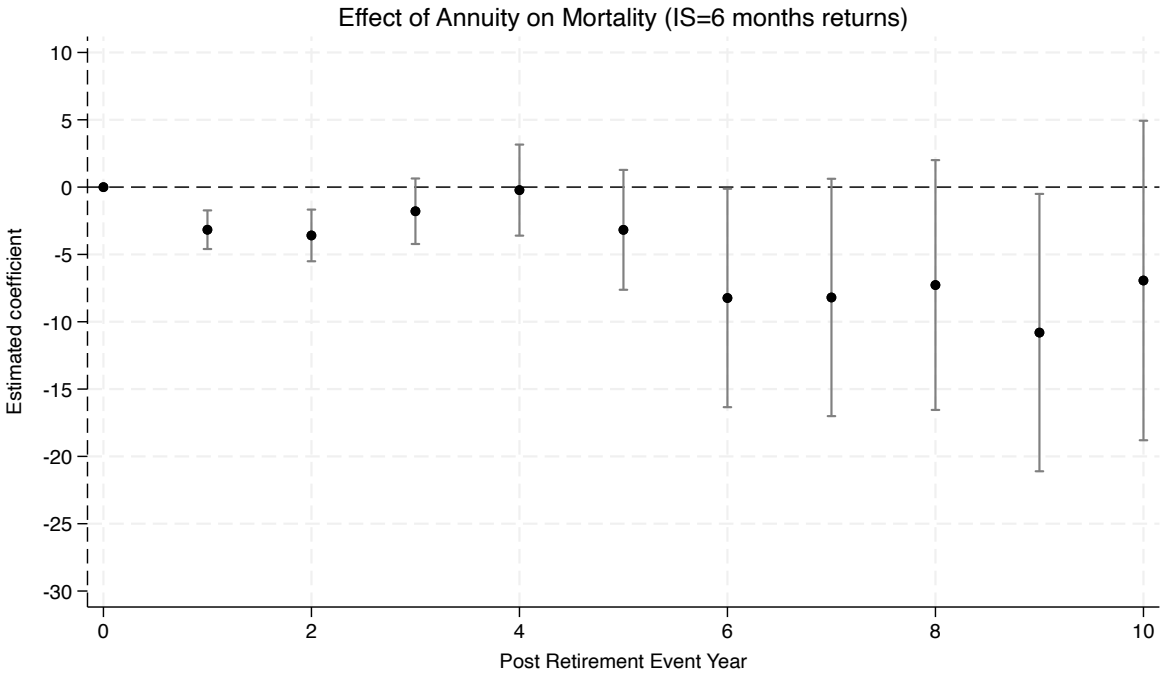
Notes: The figure shows an example of the summary of phased withdrawal (*Retiro Programado*) offers that an individual receives from the SCOMP exchange. The 1st-year monthly payment is expressed in UFs (*Pension mensual (UF) (a)*) and pesos (*Pension mensual ($)*). Several pension fund administrators (*AFP*) make bids, and the table orders them from the least to the most expensive one in terms of fees for the individual. The difference between offers (*Diferencia anual de pension ($)(b)*) is the annual fee charged by each pension fund administrator compared to the least expensive one. The graph below the table shows a simulation of future monthly payments at different ages (*edad en años*) of the individual, and under one particular pension fund administrator. This example is taken from https://www.scomp.cl/scompsa/certificado-de-ofertas-pension-vejez-CO.html.

Figure 3: Annuity Take-up



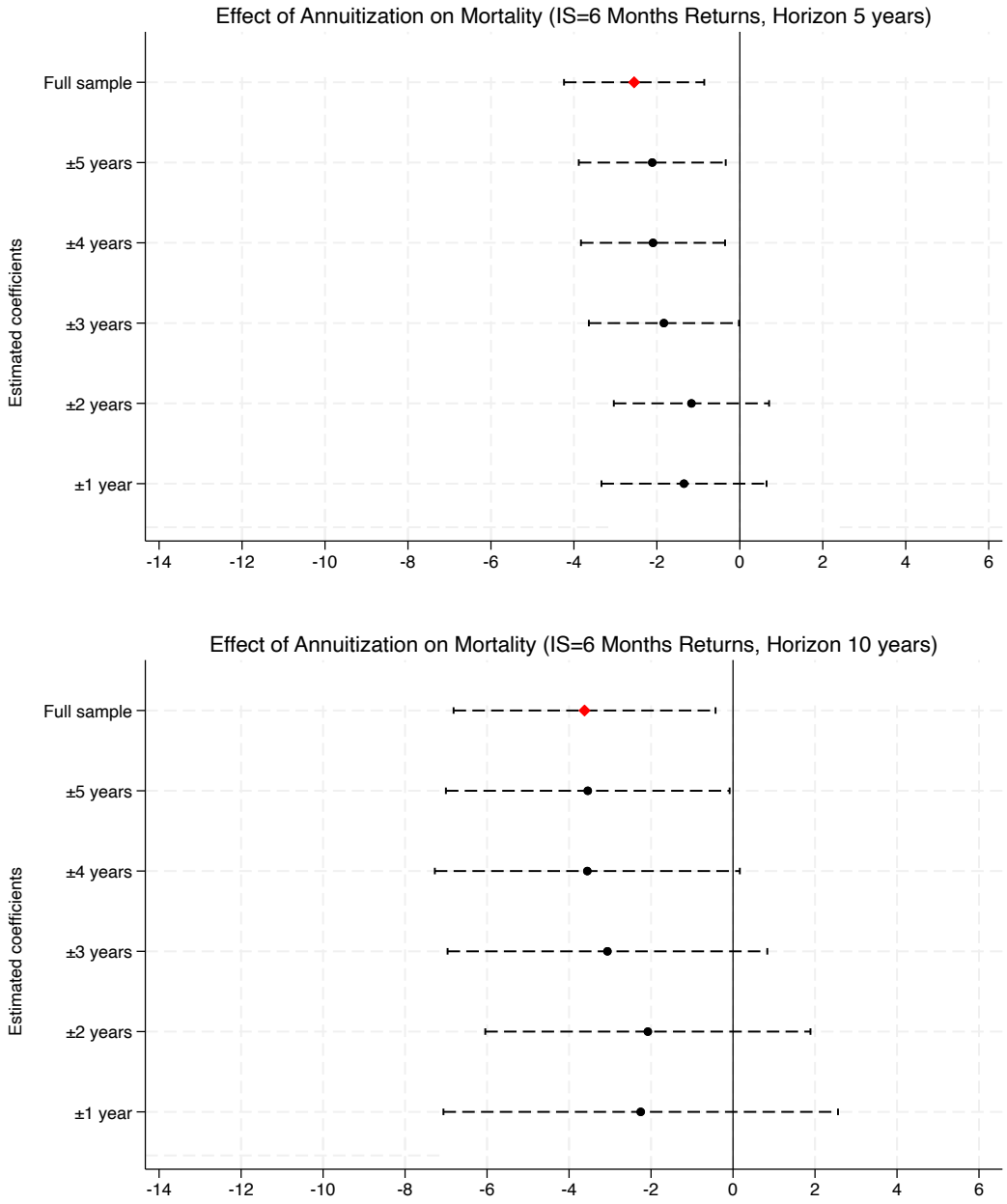
Notes: The bars represent the fraction of investors retiring each month that take annuities, and the line shows the previous 6-month cumulative returns for Fund C. Data on retirees comes from the SCOMP database.

Figure 4: The Effect of Annuities on Mortality by Post-Retirement Year



Notes: These plots estimate the dynamic effect by year post-retirement of the estimated coefficient of annuities on mortality, followed by the specification in equation 4.

Figure 5: The Effect of Annuities on Mortality by Distance from Legal Retirement Age



Notes: This figure shows the coefficient for annuities from equation 4 estimated in different sample. The full-sample estimate corresponds to the results in Table 3. The +/- 5-year sample includes men who retire between ages 60 and 70 and women who retire between ages 55 and 65, and so on.

Table 1: Summary Statistics for Retirees

The table reports summary statistics of various variables for the entire sample of retirees (All), as well as the subsamples of retirees with Phased Withdrawal (PW) and Annuities (AN). The data consist of all retirees in the SCOMP system between 2004 and 2022. Annuity is an indicator variable equal to one for retirees who choose annuities. Annuity value or initial balance refers to the total pension savings at the start of retirement, denominated in UF (inflation-adjusted unit of account). Initial monthly payment is the amount received each month during the first year of retirement. Last monthly income corresponds to income measured just before retirement. Years of contributions to pension funds correspond to the number of years during which the individual saved for retirement. Retirement age and age at death are measured in years. Returns pre-retirement correspond to the returns on Fund C (moderate fund) in the 6 months before the retirement decision (PW or AN). Early retirement is an indicator variable for individuals who retire before the legal retirement age. Dead is an indicator variable for individuals who died in our sample. Guaranteed annuity is an indicator variable for annuities with any guaranteed period of payment. The second-to-last column reports the difference in means between the AN and PW columns. The last column reports the difference between AN and PW after removing birth-year and retirement-year fixed effects. The level of statistical significance is estimated by clustering standard errors at the birth-year level. Significant at: *10%, **5% and ***1%.

	All			PW			Annuity (AN)				
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	AN-PW	FE adj.
Annuity (1=AN, 0=PW)	0.66	1.00	0.47								
Annuity value or initial balance (UF)	2,600	1,794	2,910	2,510	1,380	3,983	2,646	1,932	2,167	136*	118*
Initial monthly payment (UF)	16.3	11.5	16.0	15.5	8.4	20.1	16.7	12.5	13.4	1.2***	2.4***
Last monthly income (UF)	27.2	19.6	22.2	27.0	17.6	23.3	27.3	20.6	21.7	0.3***	3.3***
Initial payment over last income	0.93	0.59	0.83	0.89	0.53	0.83	0.96	0.62	0.83	0.07***	0.07***
Years of contributions to pension funds	26.2	27.4	8.5	26.6	28.3	9.3	26.0	27.2	8.0	-0.6**	1.8***
Retirement age	63.2	65.0	4.1	64.0	65.0	3.8	62.8	64.0	4.2	-1.2	0.0
Returns pre-retirement (months t-6 to t-1)	0.018	0.020	0.049	0.013	0.015	0.053	0.021	0.021	0.0	0.008***	-0.004**
Early retirement	0.15	0.00	0.35	0.11	0.00	0.31	0.17	0.00	0.37	0.06*	0.01*
Gender (1=Male, 0=Female)	0.66	1.00	0.47	0.70	1.00	0.46	0.65	1.00	0.48	-0.05**	-0.02**
Year of birth	1952	1952	5.4	1953	1954	5	1951	1951	5	-2	0
Dead	0.08	0.00	0.27	0.07	0.00	0.25	0.09	0.00	0.29	0.02***	-0.01**
Age of death	68.6	69.0	6.5	68.8	69.0	6.4	68.5	69.0	6.6	-0.3**	0.2***
Guaranteed annuity							0.81	1.00	0.39		
No. observations	591,909			199,704			392,205				

Table 2: Balance Test

The table reports the averages of various variables across subsamples based on fund C's returns in the 6 months before retirement. High (Low) Returns refers to individuals for whom returns are higher (lower) than the sample median. The data consist of all retirees in the SCOMP system between 2004 and 2022. Annuity value or initial balance refers to the total pension savings at the start of retirement, denominated in UF (inflation-adjusted unit of account). Initial monthly payment is the amount received each month during the first year of retirement. Last monthly income corresponds to income measured just before retirement. Years of contributions to pension funds correspond to the number of years during which the individual saved for retirement. Retirement age and age of death are measured in years. Early retirement is an indicator variable for individuals who retire before the legal retirement age. Dead is an indicator variable for individuals who died in our sample. Number of retirees per month is a month-level variable, estimated using the high and low returns sorting. The second-to-last column reports the difference in means between columns with high and low returns. The last column reports the difference between high and low returns after removing birth-year and retirement-year fixed effects. The level of statistical significance is estimated by clustering standard errors at the birth-year level. Significant at: *10%, **5% and ***1%.

	High Returns			Low Returns				
	Mean	Median	SD	Mean	Median	SD	Low-High	FE adj.
Annuity value or initial balance (UF)	2,627	1,818	3,106	2,574	1,770	2,696	-53	22
Initial monthly payment (UF)	16.16	11.34	15.80	16.50	11.56	16.12	0.33	-0.09
Last monthly income (UF)	26.10	18.55	21.74	28.27	20.72	22.69	2.17	0.05
Initial payment over last income	0.93	0.60	0.82	0.93	0.58	0.84	0.00	-0.01
Years of contributions to pension funds	25.45	26.67	8.36	26.96	28.25	8.53	1.51	-0.10
Retirement age	62.84	64.00	4.24	63.54	65.00	3.89	0.70	0.00
Returns pre-retirement (months t-6 to t-1)	0.06	0.05	0.03	-0.02	-0.01	0.03	-0.07**	-0.06**
Early retirement	0.18	0.00	0.39	0.11	0.00	0.32	-0.07	-0.01
Gender(1=Male, 0=Female)	0.66	1.00	0.47	0.66	1.00	0.47	0.00	0.01
Year of birth	1951	1951.0	5	1953	1953.0	5	2	0
Dead	0.09	0.00	0.29	0.07	0.00	0.25	-0.03	0.00
Age of death	68.79	69.00	6.55	68.26	68.00	6.48	-0.52**	0.09***
Number of retirees per month	2,751	2,731	1,126	2,755	2,585	1,373	4	-33
No. observations	297,595			294,314				

Table 3: The Effect of Annuities on Mortality

The table reports regression results for samples with horizons of 5 and 10 years. Each panel contains the OLS regression (equation 2), the reduced-form (RF) regression, the first-stage regression (equation 3), and the second-stage regression (equation 4) of the IV setup. $Dead_{i,t+j}$ is multiplied by 100, so the coefficients can be interpreted as percentage points. The instrument is the pre-retirement return of fund C over the period from $t-6$ to $t-1$. All regressions include the following controls: total pension savings, last monthly income before retirement, years of contributions to pension funds, dummies for retirement type (early, disability, old-age), retirement-month dummies, and birth-year and retirement-year fixed effects interacted with gender dummies. The Kleibergen-Paap robust F-statistic is reported for the first stage regression. Standard errors clustered at the birth-year level are reported in parentheses, and p-values are reported below standard errors. Significant at: *10%, **5% and ***1%.

	(1) OLS	(2) Reduced Form	(3) 1st Stage	(4) 2nd Stage
	Dead	Dead	Annuity	Dead
Panel A: Five-Year Horizon				
Annuity	-0.69***			-2.55***
	(0.081)			(0.862)
Returns (t−6 to t−1)		1.41***	-0.55***	
		(0.498)	(0.066)	
Observations	2,746,058	2,746,058	2,746,058	2,746,058
R^2	0.050	0.049	0.175	
Kleibergen–Paap F-statistic			69.88	
Panel B: Ten-Year Horizon				
Annuity	-0.87***			-3.62**
	(0.085)			(1.630)
Returns (t−6 to t−1)		1.67**	-0.46***	
		(0.738)	(0.055)	
Observations	4,460,606	4,460,606	4,460,606	4,460,606
R^2	0.068	0.067	0.142	
Kleibergen–Paap F-statistic			69.89	

Table 4: The Effect of Different Pre-retirement Returns on Mortality

Panel A reports the reduced-form regression for the effect of different returns *before* retirement on mortality at the 10-year horizon. Panel B reports the second stage coefficient on annuitization using the returns in Panel A as instruments. The regression specification is the same as in Table 3. Standard errors clustered at the birth-year level are reported in parentheses, and p-values are reported below standard errors. Significant at: *10%, **5% and ***1%.

	10-Year Horizon				
	(1)	(2)	(3)	(4)	(5)
VARIABLES	Dead	Dead	Dead	Dead	Dead
Panel A: Reduced Form					
Returns (t-36 through t-1)	0.28				
	(0.581)				
	0.636				
Returns (t-24 through t-1)		0.45			
		(0.598)			
		0.455			
Returns (t-12 through t-1)			2.02***		
			(0.617)		
			0.002		
Returns (t-6 through t-1)				1.67**	
				(0.738)	
				0.027	
Returns (t-3 through t-1)					1.10
					(1.054)
					0.298
Panel B: Second Stage					
Annuity [Ret. (t-36 through t-1)]	-1.53				
	(3.094)				
	0.622				
Annuity [Ret. (t-24 through t-1)]		-1.21			
		(1.580)			
		0.446			
Annuity [Ret. (t-12 through t-1)]			-7.22***		
			(2.157)		
			0.001		
Annuity [Ret. (t-6 through t-1)]				-3.62**	
				(1.630)	
				0.029	
Annuity [Ret. (t-3 through t-1)]					-1.82
					(1.732)
					0.297
Observations	4,460,606	4,460,606	4,460,606	4,460,606	4,460,606

Table 5: Characterization of Compliers

This table shows the ratio of the first-stage coefficient in a subsample divided by the full-sample first-stage coefficient. Subsamples are defined using a categorical variable (e.g., men) or observations above the median of a continuous characteristic (e.g., balance). If the ratio of first-stage coefficients is above (below) 1, then the compliers are more (less) likely to have that characteristic than the full sample. The 95% confidence intervals for the ratio are computed through the delta method. The complier population is significantly different from the full sample (in terms of a given characteristic) if the confidence interval excludes the 1.

Subsample	Ratio of 1st Stage Coeffs.	95% C.I.
Men	0.959	(0.807 - 1.111)
Large Balance	0.530	(0.210 - 0.849)
More years of contributions	0.678	(0.440 - 0.916)
High replacement rate	0.540	(0.201 - 0.878)
Early retirement	0.561	(0.309 - 0.812)
At standard age	1.221	(0.719 - 1.723)
Late retirement	1.243	(1.010 - 1.477)
$50 \leq$Age<60	0.490	(0.203 - 0.777)
$60 \leq$Age<70	1.084	(0.985 - 1.182)
$70 \leq$Age	1.559	(0.921 - 2.197)
With advisor	1.074	(1.008 - 1.139)

Table 6: Placebo Test: Post-retirement Returns, Annuities, and Mortality

Panel A reports the reduced-form regression for the effect of different returns *after* retirement on mortality at the 10-year horizon. Panel B reports the second-stage coefficient on annuitization using the returns in Panel A as instruments. The regression specification is the same as in Table 3. Standard errors clustered at the birth-year level are reported in parentheses, and p-values are reported below standard errors. Significant at: *10%, **5%, ***1%.

	10-Year Horizon				
	(1)	(2)	(3)	(4)	(5)
VARIABLES	Dead	Dead	Dead	Dead	Dead
Panel A: Reduced Form					
Returns (t+1 through t+3)	1.67				
	(1.192)				
	0.165				
Returns (t+1 through t+6)		1.32			
		(1.027)			
		0.201			
Returns (t+1 through t+12)			0.61		
			(0.655)		
			0.353		
Returns (t+1 through t+24)				-0.21	
				(0.561)	
				0.704	
Returns (t+1 through t+36)					0.22
					(0.949)
					0.817
Panel B: Second Stage					
Annuity [Ret. (t+1 through t+3)]	22.61				
	(22.578)				
	0.320				
Annuity [Ret. (t+1 through t+6)]		3.95			
		(3.203)			
		0.221			
Annuity [Ret. (t+1 through t+12)]			2.07		
			(2.240)		
			0.358		
Annuity [Ret. (t+1 through t+24)]				-0.48	
				(1.285)	
				0.709	
Annuity [Ret. (t+1 through t+36)]					0.81
					(3.552)
					0.819
Observations	4,460,606	4,460,606	4,460,606	4,338,585	4,214,570

Table 7: The Effect of Annuities by Income Levels

The table reports second-stage regressions of the effect of annuity on 10-year mortality. The annuity decision is instrumented using the previous 6-month returns on Fund C. Sample splits are based on the sample median of the following continuous variables: post-retirement income, pension balance at retirement, and replacement rate. The post-retirement income for annuitants is constant and equal to the first payment. For retirees with PW, post-retirement income is computed with the Stata module `cnu` provided by the pension regulator, and assuming the retiree selects fund C after retirement. The regression specification is the same as in Table 3. Standard errors clustered at the birth-year level are reported in parentheses, and p-values are reported below standard errors. The p-value for the difference in the annuity coefficient across subsamples is also reported. Significant at: *10%, **5% and ***1%.

Sample split by:	Post-Retirement Income		Pension Balance		Replacement Rate	
	Dead	Dead	Dead	Dead	Dead	Dead
Annuity	-6.45**	-0.71	-4.66**	-3.74	-5.39**	-2.20
	(2.833)	(2.115)	(2.205)	(4.225)	(2.565)	(2.386)
	0.027	0.739	0.037	0.378	0.039	0.360
p-value of difference in coeff.		0.104		0.847		0.363
Sample	High	Low	High	Low	High	Low
Observations	2,177,309	2,175,750	2,292,160	2,168,446	2,510,666	1,949,940

Table 8: The Effect of Annuities by Ex-post Return Differentials

The table reports second-stage regressions of annuity on 10-year mortality. The annuity decision is instrumented by the previous 6-month returns for Fund C. Sample splits are based on the difference in returns between the chosen and the alternative payout option. For an annuitant, we compute the difference between the annuity yield available at retirement and the ex-post return on the most popular pension fund, Fund C. Conversely, for a non-annuitant, we compute the differential between the ex-post returns of Fund C and the annuity yield. In Column 1, we pool annuitants and PW-retirees with bad luck according to the sample median of the return differential as the cutoff. In Column 2, we examine retirees with good luck or above-median return differentials. In Columns 3 and 4, we use the top and bottom quartiles of the return differentials as cutoffs for good and bad luck. The same procedure is applied for columns 5-8 using the return differential computed over two years after retirement. The regression specification is the same as in Table 3. Standard errors clustered at the birth-year level are reported in parentheses, and p-values are reported below standard errors. The p-value for the difference in the annuity coefficient across subsamples is also reported. Significant at: *10%, **5% and ***1%.

Sample split by:	One-year return differential				Two-year return differential			
	(1) Dead	(2) Dead	(3) Dead	(4) Dead	(5) Dead	(6) Dead	(7) Dead	(8) Dead
Annuity	-2.26**	0.50	-4.01***	0.04	-1.17***	0.29	-3.29**	1.00
	(1.053)	(1.204)	(1.383)	(1.078)	(0.411)	(0.605)	(1.279)	(1.671)
	0.035	0.677	0.005	0.970	0.006	0.637	0.012	0.552
p-value of difference in coeff.		0.098		0.007		0.032		0.024
Ex-post return differentials	Bad luck	Good luck	Bad luck	Good luck	Bad luck	Good luck	Bad luck	Good luck
Cutoff	Median	Median	Top-Bottom Quartile	Top-Bottom Quartile	Median	Median	Top-Bottom Quartile	Top-Bottom Quartile
Observations	2,345,497	2,115,109	1,255,278	3,205,328	2,475,360	1,985,246	1,330,004	3,130,602

Table 9: The Effect of Annuities on Health (CASEN survey)

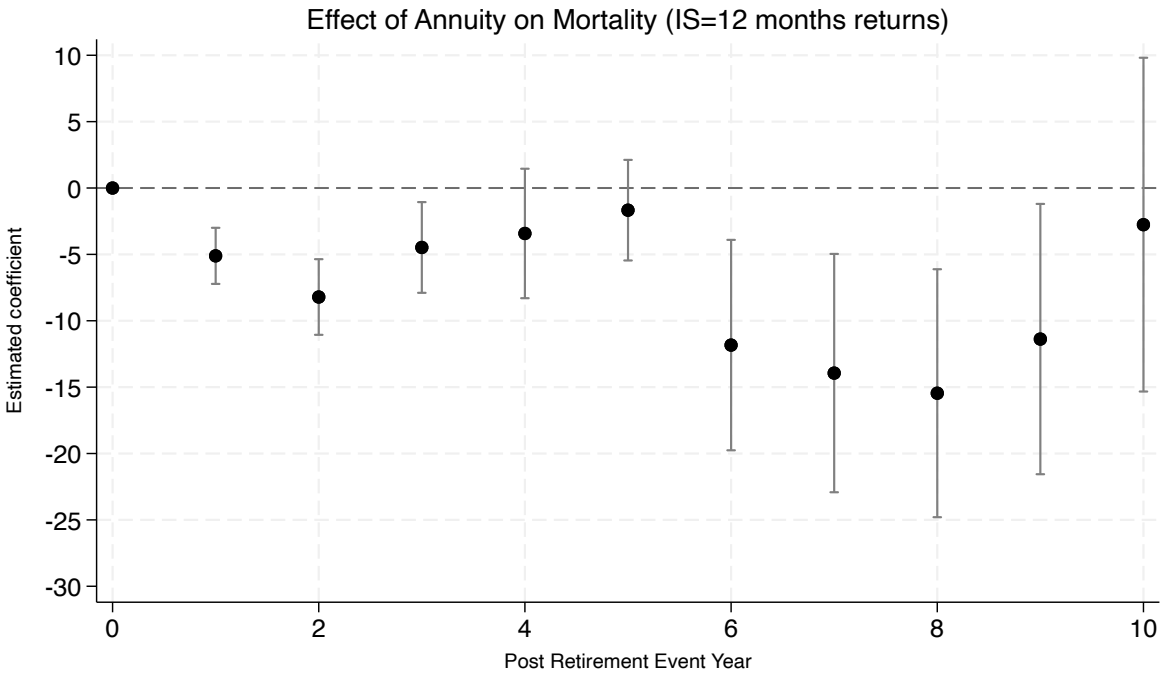
This table uses the data summarized in Table A1. Returns correspond to the returns for fund C between months $t-6$ and $t-1$, from the 65 (60) birthday month t for a male (female) retiree who declares to be X years old in each survey. Regression controls include age, income, and gender, plus fixed effects for each survey year. Robust standard errors are reported in parentheses. p-values are reported below. Significant at: *10%, **5% and ***1%.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	1st Stage	OLS	RF	2nd Stage	OLS	RF	2nd Stage	OLS	RF	2nd Stage
VARIABLES	Annuity	Any Complementary Health Insurance?			Any Health Check-up?			Mean Disability		
Annuity		0.006**		0.145	-0.001		0.578*	-0.014***		-0.794*
		(0.003)		(0.156)	(0.005)		(0.349)	(0.005)		(0.433)
		0.033		0.353	0.861		0.097	0.006		0.067
Returns (t−6 to t−1)	-0.119***		-0.022			-0.068*			0.095**	
	(0.036)		(0.023)			(0.036)			(0.041)	
	0.001		0.338			0.056			0.019	
Observations	50,101	31,747	31,747	31,747	50,101	50,101	50,101	36,487	36,487	36,487
R-squared	0.063	0.073	0.073		0.045	0.045		0.094	0.094	
Kleibergen–Paap F-stat	11.05									

The Effects of Annuities on Longevity

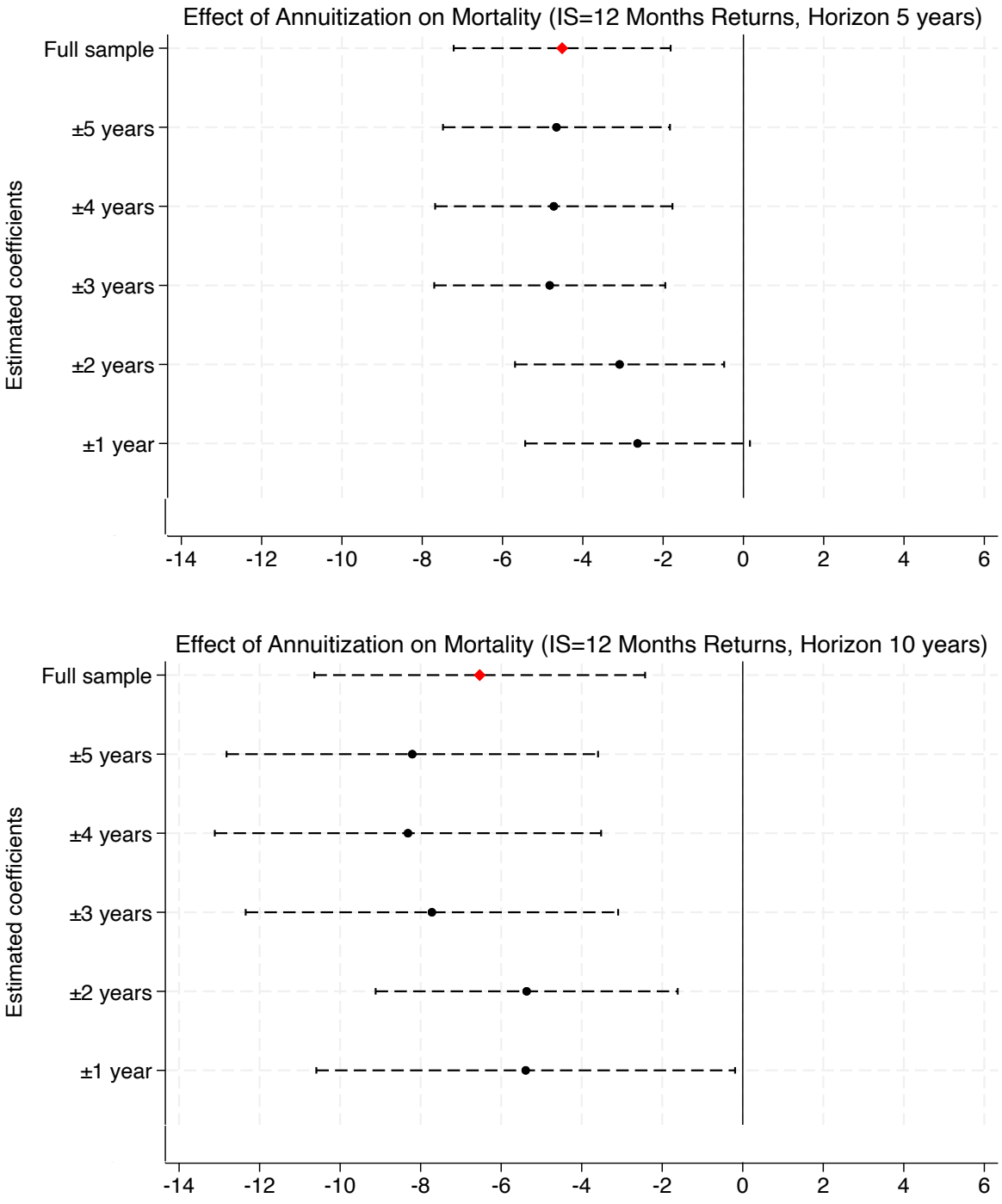
Online Appendix

Figure A1: Effect of Longevity by Year: 12 months returns



Notes: These plots estimate the dynamic effect by year post-retirement of the estimated coefficient of annuities on mortality, followed by the specification in equation 4

Figure A2: Effect of Longevity Robustness: 12 months returns



Notes: These figures estimate equation 4 using different sample specifications, full sample replicates the results in table 3, +/- 5 years defines the sample as men retirees between age of 60 and 70, and women retirees between age 55 and 65, etc.

Table A1: CASEN Survey: Summary Stats

The table reports the means for different variables for retirees in the biennial CASEN survey (excluding the COVID period). Retirees are men over 65 or women over 60 who receive non-disability pension income from an annuity or a phased withdrawal. Surveys prior to 2011 do not ask about the source of pension income. Annuity is a dummy equal to one for an annuity (AN) and zero for phased withdrawal (PW). Age is measured in years. Income is measured in UF. Male is an indicator variable equal to 1 for men and 0 for women. " Any complementary health insurance?" is an indicator variable equal to one if the respondent holds any non-mandatory health insurance after retirement. "Any health check-up?" is an indicator variable equal to one if the respondent visited a doctor in the last 12 months for preventive check-ups, related, for example, to chronic diseases. Mean Disability is the average of 10 questions about problems with day-to-day activities, such as eating, going to the bathroom, getting dressed, going out of the house, communicating, and others. Each response can go from 1 (no difficulty) to 5 (severe difficulty). Pseudo pre-retirement returns correspond to the returns for fund C in the 6 months before the assumed retirement date for each woman (60th birthday) or man (65th birthday), based on their reported ages at the time each survey was conducted. Columns 4 and 7 show the test for differences in means across sub-samples: retirees with annuities and phased withdrawals, and retirees with high and low pre-pseudo-retirement returns.

		Annuitization choice			High and Low Returns		
	All	PW	AN	AN - PW	High	Low	Low - High
Annuity (1=AN, 0=PW)	0.463	0	1	1	0.463	0.462	-0.001
Age	71.686	71.181	72.273	1.092***	72.346	71.053	-1.292***
Income (UF)	8.84	8.3	9.468	1.168***	8.512	9.155	0.643***
Male (%)	0.579	0.56	0.602	0.042***	0.578	0.58	0.002
Any complementary health insurance?	0.06	0.051	0.07	0.019***	0.056	0.064	0.008**
Any health check-up?	0.512	0.521	0.501	-0.020***	0.517	0.507	-0.009*
Mean disability	1.178	1.184	1.171	-0.013*	1.191	1.165	-0.026***
Pre-pseudo-retirement returns (t-6 - t-1)	0.024	0.024	0.023	-0.001	0.064	-0.015	-0.079***
Observations	50,101	26,920	23,181	50,101	24,527	25,574	50,101

Table A2: HRS Evidence: Summary Stats

The table reports averages of different variables for retirees in the Health and Retirement Survey. We use fully retired respondents to the surveys in 2002-2020. We compute the average for each variable across the multiple surveys where the individual appears, so each respondent is counted only once for the averages below. Any annuity means that the respondent says "yes" to the question about receiving income from annuities. Annuity>$18,000 means that annual income from annuities is higher than $18,000 (or $1,500 monthly). The no sports dummy is 1 if the respondent does not often take part in sports or vigorous activities. The smoking dummy is 1 if the respondent smokes. The log weight is the log of body weight in lbs. The log health expenses corresponds to the log of the amount paid for various health-related expenses. The possible answers to the question about retirement satisfaction are 1 (very satisfied), 2 (moderately satisfied), or 3 (not at all satisfied). The mean number of depression symptoms is the average number of "yes" answers to 8 cognitive questions (e.g.,"much of the time during the past week, you felt depressed"). Health status is a categorical variable that goes between 1 (excellent health) to 5 (poor health). Mean Disability is the average number of "yes" answers to questions regarding problems with day-to-day activities such as eating, going to the bathroom, getting dressed, going out of the house, communicating, and others. Columns 4 and 5 report the difference between averages in the previous columns. Significant at: *10%, **5% and ***1%.

	(1) Any Annuity	(2) Annuity>$18,000	(3) No Annuity	(4) Diff. (1-3)	(5) Diff. (2-3)
No sports (1= no sports; 0= yes sports)	0.581	0.594	0.627	-0.047***	-0.034**
Smoking (1=yes, 0=no)	0.06	0.058	0.149	-0.089***	-0.091***
Log weight	5.095	5.076	5.127	-0.032***	-0.051***
Log health expenses	5.023	5.027	4.914	0.109***	0.113*
Satisfied with retirement? (1=very; 3=not at all)	1.443	1.419	1.7	-0.257***	-0.281***
Mean # of depression symptoms (1=yes, 0=no)	1.269	1.226	1.815	-0.546***	-0.589***
Health status (1=excellent; 5=poor)	2.891	2.87	3.269	-0.378***	-0.399***
Mean # of disabilities (1=yes, 0=no)	0.232	0.244	0.296	-0.064***	-0.052***
Observations	2661	869	13593	16254	14462

Table A3: The Effect of Annuities by Use of Financial Advisor and Gender

The table reports OLS and second-stage regressions of annuity on 10-year mortality. The annuity decision is instrumented by the previous 6-month returns for Fund C. Sample splits are based on Financial Advisor use and Gender. Financial Advisor is a dummy equal to one if the retiree reports having an agent facilitating the process. The regression specification is the same as in Table 3. Standard errors clustered at the birth-year level are reported in parentheses, and p-values are reported below standard errors. The p-value for the difference in the annuity coefficient across subsamples is also reported. Significant at: *10%, **5% and ***1%.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample split by:	*Financial Advisor?*				*Gender*			
	Yes	Yes	No	No	Women	Women	Men	Men
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Dependent variable: Dead								
Annuity	-0.95***	-5.57***	-0.91***	4.08	-1.23***	0.57	-0.81***	-6.56**
	(0.095)	(1.903)	(0.281)	(6.026)	(0.123)	(1.362)	(0.084)	(2.644)
	0.000	0.004	0.002	0.500	0.000	0.675	0.000	0.015
Observations	3,456,921	3,456,921	1,003,685	1,003,685	1,560,424	1,560,424	2,900,182	2,900,182

Table A4: The Effect of Annuities for Retirees in Birth Months and Quarters

The table reports second-stage regressions estimating the effect of annuitization on five-year and ten-year mortality. The annuity choice is instrumented with the prior 6-month returns on Fund C. The sample is split based on whether the retiree's acceptance month matches the retiree's birth month (quarter), regardless of age. Accordingly, Panel A, Columns 1 and 3 report the annuity coefficient for the subsample of individuals who accepted their retirement offer in their birth month. Panel B, Columns 1 and 3 report the annuity coefficient for the subsample of individuals who accepted their retirement offer in their birthday quarter. The regression specification follows Table 3. Standard errors clustered at the birth-year level are shown in parentheses, with corresponding p-values reported below. The table also reports the p-value for the difference in the annuity coefficient across subsamples. Significance levels are denoted by * (10%), ** (5%), and *** (1%).

VARIABLES	(1) Dead	(2) Dead	(3) Dead	(4) Dead
Panel A: Acceptance month = Birth month				
Annuity	-6.35*	-2.33**	-2.63	-3.72**
	(3.652)	(0.922)	(6.494)	(1.778)
	0.086	0.013	0.687	0.039
Horizon	5-year	5-year	10-year	10-year
Match	Yes	No	Yes	No
p-value of coef. diff.		0.300		0.876
Observations	144,866	2,601,192	239,046	4,221,560
Panel B: Acceptance month = Birth quarter				
Annuity	-4.16*	-2.04*	-4.83	-3.40*
	(2.113)	(1.092)	(4.124)	(1.900)
	0.052	0.065	0.245	0.077
Horizon	5-year	5-year	10-year	10-year
Match	Yes	No	Yes	No
p-value of coef. diff.		0.402		0.759
Observations	686,139	2,059,919	1,102,262	3,358,344

Table A5: The Effect of Annuities by Income Levels

The table reports second-stage regressions of the effect of annuity on 10-year mortality. The annuity decision is instrumented using the previous 6-month returns on Fund C. Sample splits are based on the quartile definition, restricting the analysis to the top and bottom quartiles of the following continuous variables: post-retirement income, pension balance at retirement, and replacement rate. The post-retirement income for annuitants is constant and equal to the first payment. For retirees with PW, post-retirement income is computed with the Stata module `cnu` provided by the pension regulator, and assuming the retiree selects fund C after retirement. The regression specification is the same as in Table 3. Standard errors clustered at the birth-year level are reported in parentheses, and p-values are reported below standard errors. The p-value for the difference in the annuity coefficient across subsamples is also reported. Significant at: *10%, **5% and ***1%.

Sample split by:	Post Retirement Income		Pension Balance		Replacement Rate	
	Dead	Dead	Dead	Dead	Dead	Dead
Annuity	-8.10*	-2.96	-6.99**	-3.60	-4.85	3.10
	(4.581)	(3.743)	(2.882)	(9.142)	(3.940)	(3.329)
	0.082	0.432	0.018	0.695	0.222	0.357
p-value of coeff. diff.		0.385		0.723		0.123
Sample	Top	Bottom	Top	Bottom	Top	Bottom
Observations	1,084,921	1,088,825	1,147,341	1,027,343	1,474,958	930,535