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ABSTRACT: This study utilizes a variable derived from the Annuity Equivalent Wealth dynamic programming model developed by Brown (2001) and Mitchell et al. (1999) . The model captures the benefits of having access to the annuity market. Using a unique data set of retirees from the Chilean labor market to analyze the empirical determinants of annuity choice, the study finds that sales agent contact, good health status, knowledge about the pension system, and greater education are associated with an increase in the probability of annuitization.

KEY WORDS: annuities, pensions, welfare.

In 1981, Chile converted its old pay-as-you-go pension system into a new system based on individual accounts in which private companies, known as pension fund administrators (AFPs), are in charge of collecting and investing mandatory contributions from affiliates during their working lives. At the time of retirement, a person can choose either a pension on a phased withdrawal (PW), in which the retiree not only maintains control over the funds but also retains the longevity risk and bears the capital market risk associated with the rate of return on the investments, or as an annuity that will give a stream of income for the length of the purchaser's life but transfers ownership of the funds to an insurance company. The annuity protects the retiree from longevity risk, but the decision to annuitize is irreversible. The normal retirement age in Chile is 60 for females and 65 for males; individuals can retire earlier if they have accumulated a balance sufficient to finance a pension payout in accordance with their salary and minimum pension guarantee (MPG). Thus, the experience of more than three decades of the Chilean private pension system provides a unique opportunity to study the determinants of annuitization. Whereas globally annuities are not frequently used as a form of pension payment, Chile has one of the highest rates of annuitization in the world (Rocha and Thorburn 2006).

This paper uses a unique panel data set that contains socioeconomic information for a sample of 17,246 households that can be merged with administrative records from the pension regulator. I utilize a dynamic approach to capture the benefits of access to the annuity market. The way to compute these benefits can be summarized by the annuity equivalent wealth (AEW) for which a person would need to be compensated in the event that annuity markets were absent. In addition, I analyze other determinants of annuitization in Chile. I find that people with higher levels of financial literacy are more likely to choose annuities. Finally, sales agents can induce demand for annuities.

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Literature Review

Many studies have emphasized the effect of adverse selection on annuities (e.g., Abel 1986; Finkelstein and Poterba 2004; McCarthy and Mitchell 2010). Abel (1986) examines the implications for individual consumption and bequest motives. Using an overlapping generation model in which individuals are utility maximizers but are uncertain regarding the date of death, he shows that an actuarially fair social security market will increase the rate of return on purchased annuities and will reduce the effects of adverse selection. Finkelstein and Poterba (2004) examine annuity policies in the United Kingdom and demonstrate that, in both the compulsory and the voluntary markets, there is strong evidence that longer-lived individuals buy more back-loaded annuities. McCarthy and Mitchell (2010) provide evidence of adverse selection in annuities in an international context.[1] Other studies have emphasized the money's worth ratios (MWR), which calculate the expected present discounted value of payouts for annuities in relation to the annuity's premium cost as a way of understanding the value of purchasing an annuity (Mitchell et al. 1999). Brown (2003) acknowledges that annuities are valuable longevity insurance for individuals with uncertain lifetimes. In his model, however, mandating annuities for all individuals would not be optimal because of the existence of different purchase costs and mortality distributions across groups.

Brown and Poterba (2000) find that the utility gain from annuitization is greater for single individuals than for couples. As more potential buyers are couples, this fact could help explain the low level of annuitization given the effects of adverse selection if they decide to annuitize. They also find no evidence of bequest motives as an important variable.

Using dynamic programming techniques, Brown (2001) uses a measure called the "Annuity Equivalent Wealth," first used by Mitchell et al. (1999), to report the utility value of gaining access to an actuarially fair annuity market. This variation in utility arises from differences in marital status, risk aversion, mortality risk, planning horizon, and health status. He finds no empirical support for the influence of bequest motives. Butler and Teppa (2007) study the choice between an annuity and a lump sum distribution using the AEW measure for Swiss pension funds. They use administrative records and find that the sponsor influences the annuity decision. They also determine that a low accumulation of retirement assets is strongly associated with the choice of a lump sum. This latter study is closely related to the idea of our study. However, Butler and Teppa's sample lacks an assessment of non-pension wealth and incorporates limited individual information in the analysis.

The risk-return trade-off is important in analyzing a behavioral investment strategy (Bohl et al. 2011; Fernandez 2013; Sun et al. 2013). Mackenzie (2006) recognizes that the optimal portfolio should include, in some part, both annuities and precautionary savings. Dus et al. (2005) examine different alternatives for the retirement asset decumulation process using a risk-value approach. Here, return is the expected level of benefits, and risk pertains to the uncertainty of reaching the desired level of consumption. They mention that PW plans have the advantages of flexibility and the accommodation of bequest motives, but PW plans also require retirees to formulate asset allocation and withdrawal rules that can be complex and expose the retiree to longevity and capital market risk. Horneff et al. (2010) point out that utility maximizers will gradually annuitize the portfolio, even if retirees do not have strong bequest motives. Thus, there is an annuity puzzle of sorts, given the low rate of annuitization in some countries despite the economic advantages of making this decision.

Many studies focus on the accumulation phase in Chile, but few are devoted to the decumulation period. Possible explanations include the fact that until recently there have been no individual microeconomic data to analyze the question; also the pension system is not yet considered mature (a pure affiliate must contribute to the system for roughly forty years, from the beginning of the contribution cycle to normal retirement age). James et al. (2006) found evidence of adverse selection based on individual private information about short-term health status, but they also mentioned that this did not seem to deter high rates of annuitization for retirees. In addition, they found that MWR was close to 100 percent for price-indexed annuities. They devise a measure of an individual's knowledge about the pension system and find that this variable takes higher values for annuitants. They also include a time horizon variable that explains an individual's planning horizons. James et al. (2006) include a way to control for the minimum pension guarantee, but do not really know if respondents in their sample actually had access to this guarantee, because the Social Protection Survey (EPS; see below) data they utilized lacks information about the exact number of monthly contributions for each respondent interviewed. Also, they need to use a proxy for the pension level at retirement for phased withdrawal payments because the EPS does not report this value directly. This study utilizes the same survey data for individuals (the EPS), but is able to link the administrative records of these individuals with precise information on the respondents' rights to the MPG and their actual pension accumulations at retirement. (Rocha and Thorburn [2006] report a higher MWR for Chileans with higher pension accumulations.) Thus, the present study is based on a rich new data set that combines the EPS survey with administrative records from the pension regulator.

Data and Descriptive Statistics

Data

I use the Social Protection Survey (Encuesta de Proteccion Social, EPS)[2] to explore patterns that help explain the choice between purchasing an annuity or taking a phased withdrawal at retirement. The EPS was first administered in 2002 for a sample of 17,246 households. The survey was taken again in 2004, following up with the households chosen initially and adding more households to the sample. The information relies on both individual and household responses, including variables such as gender, marital status, and age of household members. It also includes information about the worker's educational status, employment status, and some indicators of personal health. Furthermore, administrative data collected by the AFPs were appended, providing information about contributions, charges, and withdrawals. Therefore, it is possible to know the level of PW that people received or the exact moment when retirees purchased an annuity. Finally, information is available about the annuitants in the sample, specifically about the levels of pension payments they collected from insurance companies. Almost 90 percent of the early retirees and 24 percent of the retirees at normal retirement age chose an annuity, respectively (see Table 1 and Appendix A).

Sample and Variables

The sample consists of 590 nondisabled retirees who were participants in the AFP system. As noted previously, I merged sociodemographic data from the EPS with administrative data on contribution history to the AFPs. The administrative records include information on the pension balance and made it possible to compute eligibility for the MPG.

Table 1. Normal retirement and early retirement

	Early retirement		Normal retirement	
	Total	**Percent annuities**	**Total**	**Percent annuities**
1999	113,273	87.5	80,271	34.5
2000	126,752	88.1	92,404	33.3
2001	144,248	88.5	102,159	33.4
2002	156,106	89.1	109,026	34.1
2003	170,702	88.7	117,897	34.0
2004	186,867	89.2	127,690	33.8
2005	189,916	88.7	139,899	32.9
2006	194,901	88.5	153,952	32.2
2007	201,150	88.4	168,863	31.3
2008	201,261	88.6	189,590	31.0
2009	206,277	88.8	218,391	29.8
2010	216,596	88.0	295,115	24.8
2011	199,741	86.9	351,472	21.6
2012	211,312	88.0	373,894	23.6

Source: Superintendent of Chilean Pensions (Superintendencia de Pensiones de Chile), www.spensiones.cl/safpstats/stats/.sc.php?_cid=17/.

Dependent Variable

The linked administrative data indicate when each individual began to receive the PW. For those who elected an annuity, the AFP will send the person's monetary balance to the insurance companies elected by that retiree. In addition, the information on annuitants was cross-validated with the information collected for this specific group from the insurance companies. Accordingly, in our analysis, the dependent variable is equal to 1 if the individual opted for an annuity and 0 if he or she chose the PW.

Explanatory Variables

Age. Pension benefits are related to retiree age. Thus, this variable is important for people when they are discounting future pension benefits. We can expect that younger retirees will value annuity protection more highly for longevity and the lack of exposure to capital market risk.

Male. Insurance companies compute benefits using mortality tables differentiated by gender. As long as the insurers accurately capture gender differences in their survival tables, there would be no additional impact of being male on the probability of annuitization. But if the tables are inaccurate, the probability of annuitizing might be lower for men.

Marital status. Being married generates lower pension levels for men because husbands are forced by law to purchase a joint annuity covering their wives in case they die before their wives. Also, married people can pool the mortality risk within the family, and therefore should assign to annuities less value than single individuals (Kotlikoff and Spivak 1981). Consequently, we can anticipate that married people would be less likely to annuitize than single people.

Right to MPG. We can expect that people who are entitled to claim the minimum pension guarantee will be more likely to take a PW stream of payments. Such people can enjoy higher pension benefits at the beginning and have some protection later if the value of the pension they are scheduled to receive falls below the MPG value in the future.

Pension balance. We can expect an inverted-U shape for the probability of annuitization with respect to this variable. People close to MPG will prefer to take a PW payment stream since they can try to beat the capital market risk and still have downside protection from the MPG. However, people who are receiving pension benefits moderately above the MPG will value annuity protection. However, we can expect that more affluent people of pension age, with more than adequate pension benefits, will prefer to confront the aforementioned risks since they will probably have more opportunities to diversify their assets.

Non–retirement wealth. We can expect that, all else being equal, the greater the assets people have outside the pension system, the lower the probability they will annuitize. The reason is that they are able to better diversify their assets and thus keep capital market risk at a manageable level, leaving an inheritance in the event they die prematurely.

Risk aversion. People who are risk averse prefer smooth consumption streams; we expect that these individuals will annuitize their balances. Also, as longevity risk is not covered by PW, the possibility of running out of funds will increase the value of an annuity for them. This variable was also included in the Brown (2001) study. Using a question related to preferences for safety on the job, I created a dummy called "risk averse," which had a value of 2 if people chose two conservative options, 1 if they chose one conservative option, and 0 otherwise. My hypothesis is that because risk-averse people will prefer smooth consumption streams, they will value an annuity more highly. Thus, the expected sign for changes in the probability of annuitizing with respect to risk aversion is positive.

Children. People with children are more likely to consider the possibility of leaving an inheritance. Under PW, people can leave as a bequest the remaining pension balance, unlike an annuity, which does not allow inheritance. Consequently, a negative correlation between the probability of annuitization and this variable is expected.

Health. People interviewed in the EPS surveys self-reported their health status (excellent, very good, good, regular or poor, or very poor). This variable is important as a source of private information, in the sense that the decision to annuitize or to take PW should be sensitive to health status. This is one of the classical sources of private information linked to adverse selection in the annuity market (Turra and Mitchell 2008). We can anticipate that people in better health would show a higher preference for annuities because they can expect to live longer. Yet if the correlation between a person's "permanent" health status and the self-reported status in 2002 is low, the impact may be confounded.

Knowledge about pension system. It is logical that knowledgeable people are more likely to choose an annuity because we can expect that they value protection against longevity risk (a similar approach was followed by Edwards and James 2006).[3] Yet knowledge about the pension system is likely to be positively correlated with education, and this may crowd out the power explanation of the variable. The expected sign associated with this variable is positive.

Sales agent contact. It is well known that agents play a key role in the Chilean pension market by switching workers across AFPs (Berstein and Ruiz 2004; Mitchell et al. 2008). Although AFP sales agents receive high monetary incentives for switching people, they do not receive payment for encouraging retirement. Accordingly, it can be predicted that

having contact with a sales agent will affect selection of the PW. By contrast, insurance agents receive compensation according to the number and size of the pension balances brought to their parent companies. In addition, the marketing incentives for early pensions are strong and effective (about two-thirds of retirees retire early). Thus, I predict that this variable will have a positive effect on purchasing an annuity. This variable was used in Edwards and James (2006) and proved to be significant as a predictor of annuitization.[4]

Education. We can expect that more educated people have higher salaries, which are highly correlated with expected pension levels. People with more education should therefore know more about the pension system and place a value on longevity insurance (this control variable was also used by Brown 2001 and Edwards and James 2006). I use four categories for education: primary level (default), high school level (ed1), and technical (ed2) or university studies (ed3). I hypothesize that the probability of annuitizing is positively associated with educational level (James et al. 2006).

Table 2 summarizes the variables used in the present analysis. Percentages were as follows: 77 percent annuitized, 57 percent married men, 76 percent male. On self-reported health, 9 percent were in excellent health, 52 percent in very good health, 32 percent in good health, and 7 percent in poor or regular health (default). For the variables that proxy financial literacy, 32 percent had a secondary education, 2 percent had a technical education, and 11 reported college studies; 90 percent had a right to the MPG. Finally, 23 percent of the people had sales agent contact as a proxy for conditions in the annuity market.

Methodology

The methodology employed models choice behavior as influenced by the difference in expected utility between purchasing an annuity and taking PW. The objective is to derive an AEW measure to incorporate in an empirical model of the annuity choice.

The Model

Assuming that individuals are expected utility maximizers, it is optimal for an individual to choose an annuity instead of a PW payment at retirement if $E(U(Annuity)) > E(U(PW))$.

Expected Utility (EU) Under Annuity

If the individual chooses to buy an annuity, he signs a contract in which he pays an initial up-front sum to the insurance company, in exchange for a lifelong annuity income stream. The expected discount utility is

$$EU(Annuity) = \sum_{t=1}^{T-age+1} \frac{p_t U(C_t)}{(1+\rho)^t} + \frac{(1-p_t)p_t^w \alpha dU(0.6C_t)}{(1+\rho)^t}, \tag{1}$$

where T is the maximum possible life-span of an individual, *age* is the retiree's age at time t, $U(C_t)$ represents the utility level defined over the consumption in period t, p_t is the probability of remaining alive at period t, ρ is the utility discount rate, d is a dummy that takes the value of one if the person is male, and α represents the importance the individual places on leaving a pension for his widow (annuities and PW give widows a benefit equivalent

Table 2. Summary statistics of the variables used in models (*n* = 590)

Variable	Mean	Standard deviation	Minimum	Maximum
Annuitize	0.77		0	1
Age	58.8	4.81	51	78
Male	0.76		0	1
Married	0.66		0	1
Married male	0.57		0	1
Right to MPG guarantee	0.90		0	1
Pension balance (1000 UF)	2.21	1.91	0.5	14
Non–retirement wealth (1000 UF)	3.21	20.97	0	482.3
Risk aversion	0.93	0.38	0	2
Children	0.70		0	1
he1	0.09		0	1
he2	0.52		0	1
he3	0.32		0	1
he4	0.07		0	1
Sales agent contact	0.23		0	1
K1	0.05		0	1
K2	0.45		0	1
ed1	0.32		0	1
ed2	0.02		0	1
ed3	0.11		0	1

Source: Encuesta de Proteccion Social (EPS) (2004).

Notes: UF = Unidad de Fomento. "he" is health status reported (1 = excellent, 2 = very good, 3 = good, 4 = regular or poor); K1 and K2 are knowledge proxies; ed1, ed2, and ed3 are education levels: high school, technical, and university, respectively; default is primary or lower.

to 60 percent of husbands' pensions). Here we are assuming that there are no children who can receive the survivorship benefit. We can see directly from the specification that a female does not leave a survivorship pension for her husband ($d = 0$).

Consumption streams are determined when the individual decides to purchase an annuity. I assume that the only annuity available is a real annuity (the pension is adjusted to the consumer's price index). Consequently, the income stream the person will receive by purchasing the annuity is

$$C_t = \begin{cases} \overline{C} & \text{if } \overline{C} \geq MPG_t \text{ or she is not eligible for } MPG \\ MPG_t & \text{if } \overline{C} < MPG_t \text{ and she is eligible for } MPG \end{cases} \tag{2}$$

Workers who make pension contributions for at least twenty years and who are poor in old age will receive a pension that covers at least the MPG prior to 2008. In practice, the twenty-year requirement is the most important requirement given the patterns of employment/unemployment in the Chilean population (Arenas et al. 2008).

Expected Utility Under PW

Under this payout option, individuals can decide how much of the pension accrual they will consume each period, and the amount that they will save in order to increase future

consumption. It is assumed that individuals retain the same AFP portfolio in which they have their balances as of the retirement date. I will solve by using dynamic programming techniques for the optimal path of consumption. Let $U(C_t)$ represent the utility level defined over consumption in period t, ρ is the utility discount rate, and d is a dummy that takes the value of one when the individual is male. The problem is to maximize the discounted utility until the age of death considering survivorship benefits. Maximization is as follows:

$$\max_{C_t} \left[\sum_{t=1}^{T-age+1} \frac{p_t U(C_t)}{(1+\rho)^t} + \frac{(1-p_t)p_t^w \alpha \left[dU(0.6C_t) + (1-d)U(W_t) \right]}{(1+\rho)^t} \right]. \tag{3}$$

This is subject to the constraints:

$$W_t \text{ is given at } t = 0 \tag{4}$$

$$W_t \geq 0 \text{ for all } t \tag{5}$$

$$W_{t+1} = (1+r)(W_t + P_t - C_t) \tag{6}$$

$$P_t = \frac{B_t}{12 \cdot CNU_{i,t,r_p}}. \tag{7}$$

In these constraints, W_t is the AFP account balance the individual has available to draw down in period t, C_t is the consumption level at t, P_t is the benefit level at t, and $CNU_{i,t}$ is the capital necessary to finance a pension unit for the individual i at time t. We can define Equation (3) as a value function satisfying the following recursive Bellman equation:

$$\max_{C_t} V_t(W_t) = \max_{C_t} U(C_t) + \frac{p_{t+1}}{1+\rho} V_{t+1}(W_{t+1}). \tag{8}$$

The advantage of the Bellman equation in solving the full maximization presented in Equation (3) is that it reduces the full maximization problem to a series of two-period problems. The latter can be solved numerically by solving backward from the last period. Maximization is subject to the constraints in Equations (4) to (7).

The strategy followed by Mitchell et al (1999) and Brown (2001) was to resolve the problem in the case in which annuities are not available and there is no bequest motive. Then, α is constrained to be zero. One can find the amount of wealth that an individual lacking access to the annuity market would pay for gaining that access. Thus, it is possible to find δW as

$$V(W^* + \delta W / \alpha = 0, \text{ for all } t) = V^*. \tag{9}$$

The specific mechanism for solving these two dynamic programming problems is presented in Appendix B.

Following Mitchell et al (1999) and Brown (2001), we can define the AEW as

$$AEW = \frac{W^* + \Delta W}{W^*}. \tag{10}$$

V^* is the utility level that the individual reaches when he is constrained to take the PW. Thus, AEW represents the maximum markup over the actuarially fair premium of an annuity that the individual would be willing to pay, given the utility level that could be attained without access to an annuity market.

Model Calibration

The models assume that the rate of time preference ρ and the rate of interest for the PW r both equal 4.62 percent and the annuity rate is 4.6 percent, given official information about these rates.[5]

Empirical Specification

The AEW measure helps us quantify the benefits of choosing annuities. In practical terms, we observe only whether people annuitize or not. Following Brown (2001), a reduced-form Probit model can be estimated as follows:

$$\Pr(Annuity_i = 1) = f(AEW_i) + \varepsilon_i. \tag{11}$$

I hypothesize that the probability of annuitization increases as the valuation for the annuity market becomes higher (higher AEW calculated). The prediction is $f_1 > 0$. Of course, other variables could also influence the decision to annuitize, which may not be fully captured by the AEW measure. Such variables could, for example, relate to financial literacy or conditions in the annuity market. Thus, the second model is extended to allow for separate effects of financial literacy on the annuity demand as well as AEW:

$$\Pr(Annuity_i = 1) = f(AEW_i, Z_1) + \varepsilon_i. \tag{12}$$

Here Z_1 captures the variables associated with financial literacy, such as the level of education or knowledge about the pension system. Again, the prediction is that the probability of annuitization increases as the valuation of the annuity market becomes higher, that is, $f_1 > 0$. The expectation is that people with financial literacy will assign extra value to longevity risk (Edwards and James 2006). Thus, the prediction becomes $f_2 > 0$.

Finally, a third model includes annuity market conditions that could also help explain annuity choice. The extended model becomes:

$$\Pr(Annuity_i = 1) = f(AEW_i, Z_1, Z_2) + \varepsilon_i. \tag{13}$$

Here Z_2 captures the variables associated with the conditions in the annuity market. The prediction is $f_1 > 0$ and $f_2 > 0$, as we describe above. Now, the sign for f_3 will depend on the variables we use for the proxy Z_2. Some variables can be expected to increase the decision to annuitize, such as being contacted by a sales insurance agent who could induce the decision to annuitize (Berstein and Ruiz 2004).

Groups of Estimation

The empirical analysis must recognize that there are people in the sample who do not have the right to choose between annuities or a PW because their pension balances are insufficient to finance an annuity that exceeds 110 percent of MPG or are equal to half of their average working income. Under Chilean rules, this group of people is assigned by default to PW. For this reason I have excluded from this group the sample in order to avoid a downward bias on the results.

The empirical analysis focuses separately on three samples of individuals. The first sample includes all individuals who are eligible to elect between pension payout options. The second includes people who satisfy all the requirements to be early pensioners and actually elect the early retirement age. The third sample includes only people who retire at the normal age or later. I expect different behaviors among these groups. People who

decide to retire early could be people in poor health, who want to quit their jobs, or who value having two sources of income since they are not forced to quit work to take pension benefits (they can receive salaries and pension benefits simultaneously). People retiring at the normal age are likely to be those lacking the pension balance to retire early, or who want to increase their future pension benefits.

Results

The average for the AEW parameter is 1.08, which means that, on average, people value the annuity slightly more than the PW. The mean value is lower than the U.S. results reported by Brown (2001), who found a value of 1.17 for his sample. In theory, this might be because of the minimum pension guarantee provided by the Chilean government, which makes it attractive to take the PW and receive higher payments at the beginning of the decumulation period, along with protection of lower but guaranteed pension benefits when the money runs out. This strategy works for people who receive initial pension benefits close to the MPG.

There is evidence that the AEW measure is useful for predicting annuitization in the full sample and the sample of early retirees (see Table 3). For the full sample, a value of AEW of 0.1 or higher increases the probability of annuitization in the range of 1–1.2 percentage points, depending on the model considered. A 0.1 increase in the AEW measure increases the probability of annuitization for the early retirement group by 0.6 to 1.1 percentage points, a result that is consistent with our hypothesis that people who receive more benefits associated with the annuity market will be more likely to annuitize. Also, after including this variable, the model fit improves a bit, compared to the models presented above. This conclusion is based on a comparison of the pseudo-*R*-squares and the log likelihood values.

For the full sample, the probability of annuitization increases along with people who have knowledge about the system, those who report good health, those who have access to the government guarantee, have children, have contact with sales agents, and possess at least a high school education. The probability of annuitization increases 16 percentage points if the people are more knowledgeable about the pension system. For health status reported, there is a positive and significant impact on annuitization for those who report being in excellent or very good health. Good health could be associated with adverse selection in this market because insurance companies are not permitted to develop quotes based on a retiree's health status. As expected from the discussion of explanatory variables, we find that the annuitization probability increases when people have children, but the result here is slightly lower. Having non–retirement wealth decreases the probability of annuitization by 0.1 percentage points for each Unidad de Fomento (UF) 1,000 (1 UF is equivalent to US$43). This result shows that people having resources other than pension assets will prefer to take the PW and bear the market risk because their overall assets are diversified. I also test the significance of the variables included in model 2 that help to explain the AEW measure. We can reject the contention that these variables are not significant at the 5 percent level ($\chi^2 = 18.44$, *F*-test). The result is reinforced in the presence of sales agents (the additional increment in the probability is 0.13 percentage points), as they play a role in the market. Having a right to the government guarantee increases the probability in the range of twenty-two to twenty-eight percentage points, depending on the model considered. This result is significant and large. One reason could be that a pensioner must have 240 months of contributions to be eligible for the MPG, which may

Table 3. The impact of variables on annuitization choice: probit regression, marginal effects, and standard errors

Variables	Full sample			Early retirement age			Normal retirement age		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
AEW	0.052 (0.042)	0.117** (0.049)	0.099** (0.042)	-0.073** (0.038)	0.114** (0.045)	0.063** (0.031)	0.054 (0.085)	0.101 (0.111)	0.099 (0.114)
Age	-0.019*** (0.005)	-0.019*** (0.004)	-0.015*** (0.003)	-0.010* (0.005)	-0.011*** (0.005)	-0.007*** (0.003)	0.028* (0.017)	0.011 (0.019)	0.010 (0.021)
Male	-0.106** (0.043)	-0.112** (0.042)	-0.069 (0.040)	-0.047 (0.042)	-0.040 (0.043)	0.023 (0.047)	-0.503*** (0.107)	-0.438*** (0.119)	-0.414*** (0.114)
Married	-0.036 (0.063)	-0.126* (0.060)	-0.065 (0.056)	0.001 (0.073)	-0.058 (0.060)	-0.0002 (0.041)	-0.085 (0.128)	-0.242* (0.138)	-0.208 (0.138)
Married male	0.240*** (0.075)	0.246*** (0.076)	0.141** (0.068)	0.137* (0.091)	0.141* (0.088)	0.025 (0.045)	0.371** (0.134)	0.413*** (0.136)	0.359** (0.138)
Right to guarantee	0.217*** (0.084)	0.272*** (0.094)	0.275*** (0.098)	0.215*** (0.105)	0.248*** (0.115)	0.235*** (0.104)	0.196 (0.137)	0.221 (0.148)	0.325** (0.152)
W = pension balance (UF1,000)	-0.005 (0.012)	0.033 (0.030)	0.013 (0.025)	-0.019* (0.010)	-0.047** (0.024)	-0.031* (0.017)	0.013 (0.034)	0.230** (0.066)	0.202*** (0.069)
W2 = W * W		-0.005* (0.003)	-0.003 (0.002)		0.002 (0.002)	0.001 (0.001)		-0.025*** (0.006)	-0.021*** (0.006)
NRW (UF1,000)		-0.001* (0.0005)	-0.001*** (0.0004)		0.008** (0.003)	0.005 (0.003)		-0.002** (0.001)	-0.002 (0.002)
Risk aversion		-0.224*** (0.068)	-0.167*** (0.105)		-0.114* (0.062)	-0.079** (0.038)		-0.565*** (0.150)	-0.460*** (0.154)
Children		0.139*** (0.045)	0.089** (0.041)		0.071* (0.040)	0.031 (0.028)		0.142 (0.103)	0.183 (0.112)
he1		0.151** (0.049)	0.130** (0.036)		0.113** (0.029)	0.069** (0.021)		0.054 (0.207)	0.144 (0.185)
he2		0.152** (0.076)	0.125* (0.077)		0.142** (0.72)	0.099* (0.061)		0.134 (0.165)	0.159 (0.175)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
he3	0.104		0.082		0.088	0.058		0.046	0.060
	(0.066)		(0.064)		(0.053)	(0.037)		(0.167)	(0.183)
K1			-0.198*			-0.157*			-0.194
			(0.125)			(0.133)			(0.164)
K2			0.155***			0.115***			0.177
			(0.037)			(0.030)			(0.112)
Sales agents			0.125***			0.108***			0.127
			(0.037)			(0.023)			(0.158)
Sales agents × K1			-0.294			-0.451*			—
			(0.253)			(0.337)			
Sales agents × K2			0.109			—			0.280
			(0.058)						(0.173)
ed1			0.067*			-0.0009			0.254*
			(0.033)			(0.027)			(0.103)
ed2			-0.112			-0.103			-0.100
			(0.165)			(0.179)			(0.369)
ed3			0.023			-0.012			-0.018
			(0.055)			(0.051)			(0.169)
Log likelihood	-280.5	-256.3	-219.1	-151.9	-140.5	-116.1	-111.8	-94.4	-81.5
Pseudo R^2	0.11	0.19	0.31	0.08	0.15	0.30	0.09	0.23	0.34
Observations	590	590	590	409	409	490	181	181	181

Notes: UF = Unidad de Fomento. "he" is health status reported (1 = excellent, 2 = very good, 3 = good, 4 = regular or poor); K1 and K2 are knowledge proxies; ed1, ed2, and ed3 are education levels: high school, technical, and university, respectively. NRW is non-retirement wealth. Standard errors of the marginal effects are shown in parentheses. * Significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

be associated with better knowledge of the pension system and its pension payouts. This impact is in addition to the evidence we find using proxies for knowledge.

For the sample of early retirees, the MPG has a strong effect. Having a right to the government guarantee increases the probability of annuitization by twenty-one to twenty-five percentage points, depending on the model considered. People who retire early value the annuity market more; they increase the probability of annuitization by 0.6 to 1.1 percentage points for each 0.1 increase in the value of the AEW measure. Consistent with our hypothesis, older people value the annuity protection less. We find that, for each one year increase in age, people reduce the probability of annuitization by 0.7 to 1.1 percentage points. There is also evidence that supports the hypothesis that people in better health value access to the annuity market more highly. Being in excellent or very good health increases the probability of annuitization by six to fourteen percentage points. I tested the significance of the variables on which the AEW measure was constructed, and was able to reject the hypothesis that the variables were not significant at the 5 percent level ($\chi^2 = 27.83$, F-test).

Finally, for people who retire at the normal age, the probability of annuitization decreases for males and increases for married males. We also find for this group an inverted-U shape in the pension balance, and people who attain a high school level of education (and beyond) will tend to annuitize more. I also tested the significance of the variables included in model 2 that help to explain the AEW measure. We can reject the hypothesis that these variables are not significant at the 5 percent level ($\chi^2 = 43.66$, F-test).

Conclusions

This study presents evidence on the probability of annuitization using a dynamic measure for a rich new data set in the Chilean case. It shows that the AEW measure for the benefits of having access to the annuity market is important and significant, and explains annuitization choices for the full sample and the early retirement group. It also finds supportive evidence that people who annuitize are in good health, which is consistent with our hypothesis. Good health is a predictor of an increase in the probability of annuitization, because people in better health are expected to live longer; evidence suggests that they will thus value the annuity more highly.

Life insurance companies pay sales agents to attract customers who will purchase an annuity, whereas AFP agents do not have a similar incentive; this market factor generates an increment in the probability of annuitization. An inverted-U wealth pattern is evident in some of the models, meaning that people are more likely to annuitize as wealth increases, but after some value the probability begins to decrease (the critical value was around UF9,000–10,000). This is consistent with our prediction, inasmuch as poor people will prefer the earlier higher payment provided by the PW, and will rely on the MPG at older ages. Rich people will prefer to make their own portfolio choices rather than annuitize; this also allows them to leave an inheritance. Finally, there is consistent evidence that people who know more about the pension system are more likely to annuitize.

Notes

1. The countries studied are Japan, the United States, and the United Kingdom.
2. The EPS was developed by the Microdata Center of the Department of Economics of the Universidad de Chile. Specialists from the Universidad de Chile, the University of Pennsylvania,

and the University of Michigan participated in the design of the survey. The survey is similar to the Health Retirement Survey in the United States.

3. See Appendix A for an explanation of this variable.

4. Information for this variable was collected from question 16 in EPS 2002 or question 84 (module E) in EPS 2004.

5. Rates were obtained from the Superintendent of Chilean Pensions (www.spensiones.cl/safpstats/stats/.menu.selector.php?_mscfg=tasas_descto_interes/).

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Appendix A: Knowledge and Risk Aversion Variables

Knowledge was proxied using EPS 2002 and 2004. Questions E14 and E15 ask, respectively:

> E14: Do you know that there is a minimum state guaranteed old-age pension for people aged 65 and over? 1. Yes. 2. No.

> E15: What are the requirements needed to obtain the minimum old-age pension guaranteed by the state? Mark all that apply: 1. Have a minimum number of contributions; 2. Have a pension less than the minimum; 3. Be poor; 4. Others; 5. Don't know.

If the interviewee answered yes correctly on E14, he or she received a one, and zero otherwise. The requirements for receiving the MPG are to have 240 months of contributions, to have an actual pension level lower than the MPG, and to possess evidence of poverty. Thus, the interviewee received one point each for marking options 1, 2, or 3 for question E15.

From EPS 2002, question 17 of module I asks: E17. Why did you choose that modality of pension?

> 1. The pension was higher; 2. The pension was for the whole lifetime; 3. The pension values were higher at the beginning; 4. I could not access the other modality; 5. I was afraid of overliving my balance and receiving no pension; 6. I received a gift from sales agents; 7. I was allowed to bequest; 8. I did not know of other options; 9. Another reason.

People who opt for PW will have a higher pension value at the beginning and leave a greater inheritance associated with the remaining balance in the event of early death. Thus, the coherent answers for these respondents are 1, 3, or 7. We also know that annuities provide a guaranteed real pension income that is constant over the whole life of the pensioner. Thus, people who purchase an annuity should provide as a correct answer either options 2 or 5. We then generated a set of dummy variables for proxying knowledge about these retirement options.

Risk Aversion: The surveys ask in question 1 from EPS 2004 and question 30 from EPS 2002: Suppose that you, as the only source of household income, have to choose between the following two jobs: Alternative A: A fixed-income job that is stable for life. Alternative B: A job where you have an equal possibility of earning double or only a quarter of your income for the rest of your life.

People who select Alternative A are asked the question again with a less variable outcome for Alternative B. Using the answers to these questions, we have assumed a constant relative risk aversion (CRRA) equal to two for people who prefer the stable

option in the first and second question, and a CRRA equal to one for people who prefer the stable income in the first question and variable income for the second question. Finally, we assume a CRRA equal to zero for people who prefer the variable income option in the first question.

Appendix B: Solving the Dynamic Problem

In this section we outline the utility maximization process we follow in order to find the annuity equivalent wealth for each individual. The process shows the procedure for both pension payouts.

For the Annuity:

$$V_A(W_t, B, p_t) = \underset{c_t}{\text{Max}} \left\{ U(C_t) + \frac{1}{1+\rho} \left\{ \begin{array}{l} p_{t+1}V_A(W_{t+1}, B, p_{t+1}) + (1-p_{t+1})p_{t+1}^w d_w \widetilde{V}_A(\widetilde{W}_{t+1}) + \\ + (1-p_{t+1})(1-d)b\widetilde{V}_A(W_{t+1}) \end{array} \right\} \right\}$$

Subject to the constraints:

$$W_{t+1} = (1+r)(W_t + A_t - C_t)$$

$$W_{t+1} \geq 0$$

$$\widetilde{W}_t = W_t + PV(0.6A_t)$$

$$A_t = \overline{A} = \frac{B}{12 \cdot CNU_{i,t,r_A}},$$

where W is the cash in the "bank," A is the annuity payment, C is the consumption, and PV is the present value.

For the Phased Withdrawal:

$$V_P(W_t, B, p_t) = \underset{c_t}{\text{Max}} \left\{ U(C_t) + \frac{1}{1+\rho} \left\{ \begin{array}{l} p_{t+1}V_P(W_{t+1}, B, p_{t+1}) + (1-p_{t+1})p_{t+1}^w d_w \widetilde{V}_P(\widetilde{W}_{t+1}) + \\ +(1-p_{t+1})(1-d)b\widetilde{V}_P(H_{t+1}) \end{array} \right\} \right\}$$

Subject to the constraints:

$$W_{t+1} = (1+r)(W_t + P_t - C_t)$$

$$W_{t+1} \geq 0$$

$$\widetilde{W}_t = W_t + PV(0.6P_t)$$

$$P_t = \frac{B_t}{12 \cdot CNU_{i,t,r_p}}$$

$$H_t = W_t + B_t,$$

where W is the cash in the "bank," A is the annuity payment, C is the consumption, PV is the present value, and P is the pension amount under the phased withdrawal rule.