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Annuity selection in the presence of insurer default risk and government guarantees

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Abstract

We investigate whether individuals correctly assess the risk of default of annuity providers and incorporate this information into their decision-making when purchasing an annuity. To do so, we analyze actual retirement product choices from a large administrative data set from Chile and exploit an exogenous change that decreased the coverage of government guarantees against annuity provider default. If individuals are rational and properly incorporate default risk into their decision process then, before this change, individuals should choose riskier providers that give higher annuity payments. However, we find that individuals' decisions are not influenced by changes in their protection against the risk of provider default. It seems that individuals have been unnecessarily reducing their annuity payments by not incorporating crucial information about their actual risk exposure to default when selecting annuities at retirement.

KEYWORDS

annuities, decumulation decision-making, default risk, information, retirement income

JEL CLASSIFICATION

D81, D83, D91

1 | INTRODUCTION

Choosing a decumulation product at retirement is a complex financial decision. It requires individuals to manage and trade-off a range of risks and uncertainties, as well as make comparisons of different design features, for example, flat versus indexed annuities, across unfamiliar financial products (Brown et al., 2017). To do this effectively an individual would have to be not just financially literate but sophisticated in their understanding of financial products, be able to project their future retirement needs over an indeterminate period of time and make sound judgments about their life expectancy (Bateman et al., 2016). The fact that such decisions have both significant economic implications for an individual's well-being in retirement and are usually irrevocable adds to the cognitive challenge of such a complex decision (Bateman et al., 2017).

Although annuity products are meant to largely reduce much of this complexity, and their optimality has been theoretically demonstrated (see Yaari, 1965), annuitization rates are still significantly lower in most pension systems than theory would predict (Agnew et al., 2015).

Prior research has established that there are several rational factors such as bequest motives, risk aversion, and adverse selection in the annuity market that can explain this phenomenon, but only partially (Brown et al., 2008; Pashchenko & Porapakkarm, 2022). Alongside this rational perspective there is a growing literature that emphasizes the role of behavioral biases in individuals' annuitization decisions. For instance, research has consistently shown a framing effect whereby annuitization decisions are affected by the frame used to describe the features of annuity products, for example, frames that focus on the inflexibility of the product and loss of control tend to reduce annuity demand (Agnew et al., 2008; Beshears et al., 2014; Bockweg et al., 2018; Brown et al., 2008; Goedde-Menke et al., 2014). In turn, psychological errors related to mental accounting and loss aversion also have an effect as individuals may refuse to purchase annuities due to the potential large losses resulting from early death (Benartzi et al., 2011; Hu & Scott, 2007). Additionally there is evidence of individuals exhibiting hyperbolic discounting (Schreiber & Weber, 2016), excessively extrapolating past stock returns (Agnew et al., 2015; Chalmers & Reuter, 2012; Previtero, 2014) and suffering from inertia and ending up with the default option (Bütler & Teppa, 2007).

One factor that may affect the relative attractiveness of an annuity is any suggestion of the risk of insurer default. Such a risk is at odds with the relative safety and stability that characterize annuity products. Risk-averse individuals, that would be expected to opt for an annuity at retirement to avoid the risk of outliving their pension savings, may therefore not annuitize in the presence of default risk by annuity providers (Hanewald et al., 2013).

Appropriately incorporating information about provider default risk into retirement product decisions is complex. Moreover individuals have difficulty in consistently valuing annuity products, even when faced with a relatively simple experimental setting that presents a dichotomous choice between an annuity and a lump sum (Bateman et al., 2016; Brown et al., 2017; Chalmers & Reuter, 2012). Outside of the laboratory, individuals are faced with the existence of multiple providers offering different types of annuities, each of whom will have a different risk of insolvency, and so individuals are faced with complex trade-offs between provider and product characteristics.[1]

[1]Prior research has shown that when individuals choose between providers of nonpension insurance products, they exhibit behavioral biases that result in poor decisions (see, e.g., Abaluck & Gruber, 2011; Bhargava et al., 2017; Keane & Thorp, 2016).

While prior research has documented a negative effect of annuity providers' default risk on optimal allocations to annuity products (Babbel & Merrill, 2006; Hanewald et al., 2013; Lopes & Michaelides, 2007; Schulze & Post, 2010) to date there is almost no literature that investigates this issue empirically as opposed to theoretically.

We analyze over 80,000 actual annuity selection decisions and present empirical evidence from real-world choices as to whether individuals can value the risk of default of an annuity provider in the presence of government guarantees that provide some limited protection against provider default. Specifically, we examine whether individuals are sensitive to their actual exposure to annuity providers' default risk, that is, whether an individual is willing to accept increased payments from a higher-risk provider when the coverage of government guarantees is greater.

Since August 2004, the retirement process in Chile has been organized around a mandatory centralized electronic quotation system that brings together individuals looking for retirement products and the providers of these products. In this system, individuals make requests for pension products that they are interested in and receive offers from providers. In general, annuity offers provide an individual with two pieces of information: the value of the pension offered, and the risk rating of the product provider.

As better offers with higher payments tend to come from riskier providers, retirees therefore usually face a trade-off between the value of monthly payments received and the default risk of the insurer. Taking the best value offer as a reference point, many individuals sacrifice some pension income and go with a lower-risk provider. Although this could be motivated by individual preferences, for example, risk aversion, in aggregate, looking at the actual decisions of individuals in our sample buying annuities between August 2004 and June 2019, around 24,000 individuals have lost circa $3 million a year by not choosing the offer with the highest pension payment. There were no provider defaults in that period.

In Chile, as implied above, if an insurer defaults, the government partially guarantees annuity payments. The extent of this guarantee ranges between 77% and 100% of the original annuity contract with a maximum monthly payment of around $2000. For individuals whose pension is equal to the state pension, they receive full payment, as this is the minimum pension level required by legislation for an annuity to be purchased. While for those whose pension is greater than the minimum pension, the level of coverage decreases to 77% with a maximum payment of $2000 a month.

In this setting any changes to the minimum pension offered by the state affects the extent of the government guarantee against provider default. Changes in the minimum pension therefore create an exogenous shock to coverage of the government guarantee, as was the case in 2009 when the minimum pension decreased by around 30%. These unique features of the retirement process in Chile present a setting that allows us to empirically investigate the impact that the risk of provider default has on individual annuity selections. Specifically, the question we seek to answer is: do people tend to choose more highly rated annuity providers when the default insurance declines?

The exogenous change in the minimum pension generated a discontinuity in the average coverage rate, which decreased by around 3 percentage points (see Figure 1). However, the proportion of new retirees discarding the best value offer in favor of an offer of less pension value but that comes from a less risky insurance company did not substantially change (see Figure 2).

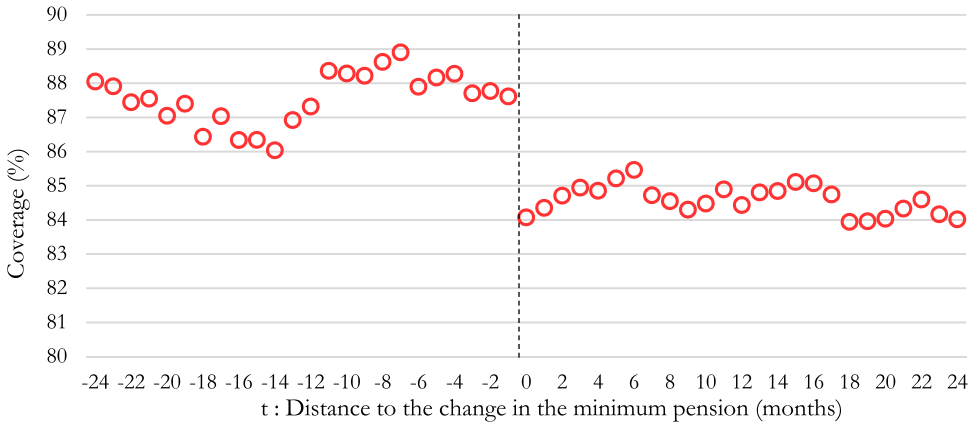

FIGURE 1 Coverage rate (pay-off fraction) in case of default—new retirees, monthly average. Each dot reports the average coverage rate for all new retirees of the period. [Color figure can be viewed at wileyonlinelibrary.com]

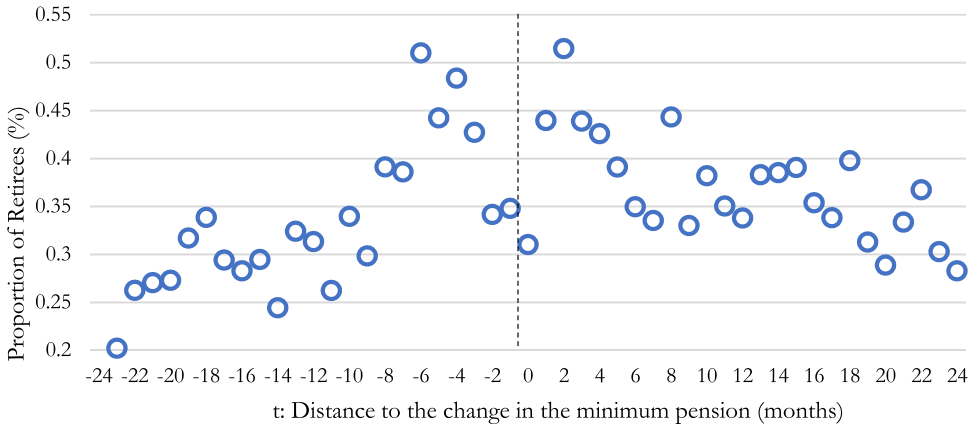

FIGURE 2 Proportion of individuals favoring highly rated providers—New retirees. This shows the proportion of new retirees not choosing the best value offer, that is, choosing an offer of less pension value but that comes from a less risky insurance company. [Color figure can be viewed at wileyonlinelibrary.com]

To formally analyze this we first apply a regression discontinuity (RD) design, where the discontinuity in the minimum pension is used as an instrument for the extent to which an individual is covered by government guarantee in the event of provider default.

We next examine individuals' preferences for particular insurance companies based on the characteristics of the insurer, for example, the size of an insurer might affect its subjective reliability regardless of its formal risk rating. We therefore implement mixed logit models of the annuity selection and include the pension value and insurer default risk as relevant attributes as well as other provider characteristics.

Our results show no evidence of changes in the willingness of individuals to pay for reducing the default risk of their annuity provider when individuals' exposure to default risk increased after the 2009 change. This suggests that individuals do not take into account the risk

of provider default in their decision-making, even when this information is widely available. When these analyses are performed on a sample stratified by the value of individual pension pots at retirement, the richest retirees show a rational response to changes in default risk exposure, suggesting that the poor decision-making is limited to low- and middle-income individuals.

The rest of this paper is organized as follows. Section 2 presents a review of the literatures on annuitization, providers' default risk, and attribute valuation. Section 3 provides an overview of the Chilean pension system. Section 4 explains the change to the minimum pension in detail. Section 5 describes the data, defines key measures, and provides summary statistics. Section 6 details the methodology. Section 7 presents and discusses our empirical results and Section 9 concludes.

2 | LITERATURE REVIEW

2.1 | Annuity demand and providers' default risk

Annuities are a relatively safe retirement product as they are largely provided by insurance companies. However, the fact remains that there is a possibility that an insurance company can become insolvent, resulting in the suspension of annuity payments. Provider default risk is not therefore inconsequential for individuals' well-being in retirement and should be incorporated into the annuitization decision-making process (Boon et al., 2020).

By the same token, in the absence of default risk, annuities are able to protect individuals from longevity risk and so, all other things being equal, it should be the dominant decumulation strategy (Hanewald et al., 2013). However, a positive probability of default by the annuity provider is equivalent to exposing individuals to systematic longevity risk, that is, mismanagement of the aggregate mortality risk by an insurance company increases the chances of insolvency and annuitants' income being drastically reduced (Boon et al., 2020; Schulze & Post, 2010).

Notwithstanding the above, and although there exists a substantial body of research regarding the decision to annuitize, less attention has been given to the effect of insurer insolvency risk on annuitization. To date only a few studies have examined these issues, focusing on the theoretical effect of annuity providers' default risk on annuity demand. In general terms, higher levels of default risk lead to a reduction in annuity demand (Babbel & Merrill, 2006; Hanewald et al., 2013; Jang et al., 2019; Lopes & Michaelides, 2007; Peijnenburg et al., 2016; Schulze & Post, 2010). However, the magnitude of this effect is debated (Alexandrova & Gatzert, 2019). For instance, Babbel and Merrill (2006) document a large effect of modest levels of default risk on optimal levels of annuitization. Specifically, the theoretical optimal allocation of annuity products for individuals falls from 75% in a situation with no risk of default to 20% where the insurance company issuing the annuity to have a default rating of "AA." Conversely, Lopes and Michaelides (2007), using a different set of assumptions and functional forms, find that, at similar perceived probabilities of default risk, the demand for annuities is almost the same for annuities with or without risk, implying insurer default risk is not a factor in the demand for annuities.

Regarding the empirical evidence on this subject, Lee et al. (2019) analyze how both individual and product characteristics affect the annuity demand. To this end they conducted a discrete choice experiment in Hong Kong in which individuals face hypothetical decisions

between two annuities and a nonannuitization alternative. The set of product characteristics they test includes different payment structures and three levels of provider default risk. They identify the existence of a guarantee period and the inclusion of inflation protection as the two characteristics most relevant for increasing the demand for annuities, while the risk rating or default probability of the insurer is a substantially less important attribute.

For other insurance-related products experimental evidence contradicts these findings. In particular Zimmer et al. (2009) examine individuals' willingness to pay for insurance contracts from providers with different default probabilities. Here individuals made hypothetical decisions about household insurance in the presence of default risk being explained and framed in different ways. The results show that many individuals are not willing to accept any amount of default risk, while others would accept it, but only in exchange for a considerable reduction in premiums. In addition, individuals' reluctance to accept insurance with default risk was irrespective of how default probabilities are presented. This suggests that individuals buy insurance to have certainty and reduce their own risks and so, for most individuals, buying insurance that is subject to risk, even when small, is barely tolerable.

Similarly, and focusing on theft insurance contracts, Zimmer et al. (2018) confirm that individuals' willingness to pay for insurance sharply decreases in the presence of a positive probability of default risk, and this is independent of gender, risk aversion, and other observable individual characteristics.[2]

In the context of annuities, prior research has highlighted the importance of government guarantees that protect annuitants from providers' default risk. Specifically, if the government undertakes to pay at least a fraction of the original annuity purchased in case of insolvency by the insurance company then the impact of this risk on the annuity demand is considerably lower (Babbel & Merrill, 2006). In that regard, it has been posited that the pay-off fraction that the individual would receive in case of default is a crucial factor in decision-making, and it is substantially more influential than the default probability itself (Schulze & Post, 2010).

In addition, a government guarantee would mitigate the reduction in annuity demand caused by the presence of provider default risk, even if the guarantee is relatively low. For instance, Babbel and Merrill (2006) document that large declines in the propensity to buy annuities in the presence of a small default probability can be almost entirely reversed if individuals are entitled to recover 25% of their original annuity. Nevertheless, the authors emphasize that the recovery rate that effectively influences individuals' decisions is what they expect at the time of the annuity purchase rather than the actual recovery rate. Thus, if most people buying annuities in a private market with a state guarantee do not know of the existence of such a guarantee or are not knowledgeable of the pay-off fraction they would receive in the event of default, they would make decisions as if they bore the whole risk. It is also highly plausible that retirees are unaware of such guarantees where they do exist. For instance, Li et al. (2021) indicate that, in the United States, there is a state guarantee in place that completely eliminates the default risk for individuals, but it is

[2]They also analyze the consequences of this phenomenon for firms' optimal risk management. Specifically they use a theoretical model to determine insurance companies' optimal solvency level considering the sensitivity of the insurance demand to default risk as inferred from their experiments. They find that insurance companies should select a default probability of zero instead of a small default probability to maximize shareholder value, even in the presence of the significant transaction costs that would be associated with the managerial activities needed for default risk reduction.

largely ignored by potential and current annuitants as annuity providers in most of the states cannot advertise this insurance.[3]

It has also been argued that the existence of these government guarantees on annuity payments improves social welfare, as default events strongly affect retirees' standard of living (Huang et al., 2008). If retirees are not aware of the existence of guarantees, the benefits of having such guarantees in place are substantially reduced, but, nevertheless, are still positive (Li et al., 2021).

2.2 | The challenge of valuing annuity products

There is a growing literature that supports the view that individuals struggle to properly value annuities and are susceptible to behavioral biases when selecting the correct annuity at retirement (Bateman et al., 2016; Brown et al., 2017; Chalmers & Reuter, 2012). For example, Chalmers and Reuter (2012) analyze actual choices made by individuals when deciding between purchasing an annuity or taking a lump sum payment and conclude that individuals do not respond to variations in the magnitude of annuity payments. Specifically, annuity demand does not increase when the risk-free interest rate is lower, and so the sensitivity to cross-sectional variation in annuity pricing is limited. This finding goes against what rational economic models of behavior would predict. Although retirees understand how their own health or risk aversion impacts the value of annuity products, demand does not increase even when the specific annuity offered within the pension plan improves relative to a market benchmark (Chalmers & Reuter, 2012).

Similarly, in an online experiment, Bateman et al. (2016) show that Defined Contribution (DC) pension plan members that were older and therefore nearing retirement, when presented with hypothetical allocation decisions between an annuity with no guarantee period and a risky phased withdrawal account, finds that almost half of the participants exhibit a demand for annuities that is unaffected by the probability of completely extinguishing their pension savings before death.

Brown et al. (2017) utilize a two-wave randomized experiment to investigate the internal consistency of annuity product valuation by individuals. Specifically, participants were offered the opportunity to exchange a hypothetical annuitized income stream from their social security benefits for a lump sum and vice versa. The results show that there is an endowment effect. As such, the price at which individuals would buy an annuity is considerably lower than the price at which individuals would sell it, again highlighting the degree of difficulty experienced by individuals in valuing annuities.

In trying to explain why individuals struggle with making decisions when choosing annuities, one explanation that has been given is the generally low levels of financial literacy that have been observed in the general population (Lusardi & Mitchell, 2014, 2017). For example, Bateman et al. (2018) show that individuals with higher financial literacy exert effort to understand the characteristics of different retirement products and are less subject to behavioral biases when faced with the annuitization decision. Specifically, where individuals

[3]Li et al. (2021) argue that this ban on advertising government guarantees is presumably motivated by moral hazard concerns although those concerns are not sufficient for rationalizing the existence of such a prohibition.

have higher levels of financial literacy, framing effects virtually disappear, and the gap between the price at which individuals would buy and sell an annuity narrows considerably.

While financial advice can reduce the difference between the prices at which individuals would buy and sell an annuity, it does not eliminate it. In this respect, Bateman et al. (2016) find that basic financial knowledge, as measured by common tests of financial literacy, for example, Lusardi and Mitchell (2011), is insufficient to help individuals improve decision quality and efficiently manage the risk of outliving their accumulated pension resources in retirement. Moreover, institutional effects also play a central role in individuals' understanding of pension products, and hence in their abilities to correctly value annuity products, for example, small annuity markets are associated with consumers being unfamiliar with annuity products (Bateman et al., 2018).

2.3 | Assessing providers' and product characteristics

Individuals that decide to annuitize are required to choose a specific annuity product, and given the similarity of many of the annuities sold in the market, they also select the insurance company that provides it (Benartzi et al., 2011). How individuals make that decision, which providers and product characteristics they analyze, and how often their choices deviate from the predictions of standard economic models of rational choice, are still open questions.

The literature examining the decision-making process underlying retirement product selection focuses on annuity demand and, although there are a few exceptions, usually simplifies the annuity option to a single generic product offered by an unspecified provider. As such, it has been posited that in the UK and the Netherlands most retirees choose an annuity product from their pension savings provider instead of looking for better options in the open market, even when by doing so they could substantially increase their pension outcome. The pension improvements from going to the open market vary from between 5% and 7% of the annual income of the retiree (Banks et al., 2015; Cannon et al., 2015). This evidence is consistent with individuals defaulting to their original provider, which in turn could affect the level of competition in these annuity markets. For example, Banks et al. (2015) find that, in the Netherlands, where insurance companies are allowed to offer different annuity rates to individuals coming from external providers than to existing customers, annuity providers do not offer lower external prices to encourage additional purchases.

There are interesting corollaries with the growing literature examining individuals' health plan choices. Although the health plan decision context is different from that surrounding annuitization, they share some similarities; in both cases individuals decide between several alternatives which are characterized by the attributes of both providers and plans, and comparisons across alternatives typically imply multiple trade-offs.

This literature has emphasized that individuals are usually not active and fully informed decision makers as the standard economic model assumes. Most individuals are therefore not able to correctly understand basic health plan attributes, and experience difficulty in assessing the costs and benefits of insurance alternatives (Ericson & Sydnor, 2017). Crucially, this consumer confusion results in a divergence between the real and perceived features of options as well as an inefficient allocation of insurance (Keane & Thorp, 2016). In this respect, experimental evidence presented by Johnson et al. (2013) shows that individuals are not able to identify the most cost-effective health plans and perform as well as if they randomly selected a product, even when the set of plan attributes is limited. Johnson et al. (2013) also report that

adding monetary incentives to select the best option does not improve the quality of decision-making and individuals are wholly unaware of their poor performance.

Recent studies analyzing individuals' actual choices on health insurance have shown that dominated alternatives are usually found in the set of health plan options that individuals face in Germany (Bünnings et al., 2019) and the US (Afendulis et al., 2015; Bhargava et al., 2017; Sinaiko & Hirth, 2011) and that substantial numbers of individuals indeed choose a dominated plan. For example, Bhargava et al. (2017) document that a large proportion of workers choose financially dominated health plans, which implies an annual excess cost of over $350 per individual, corresponding to 25% of selected plan premiums. In addition, individuals do not tend to amend their choices in the following year by switching to more efficient plans. This behavior is plausibly attributable to a lack of financial literacy preventing individuals from properly understanding health insurance and the varying characteristics of plans. Similarly, it has been pointed out that individuals tend to over-weight some plan features in their decision-making, tending to value plan characteristics irrespective of their impact on their own financial situation, and undervalue the risk-reducing attributes of health plans (Abaluck & Gruber, 2011).[4]

Generally, the literature has highlighted that individuals are susceptible to multiple behavioral biases when selecting annuities or making other complex insurance decisions. Understanding more specifically which information is not being correctly incorporated into individuals' decisions is crucial to guide decision makers towards better choices. In that context, this paper investigates whether individuals' willingness to pay to decrease provider risk increases when they are more exposed to such risk, as predicted by standard economic theory.

Section 3 outlines the main characteristics of the Chilean pension system, and describes the government guarantees in case of default by the insurance companies in the annuity market.

3 | INSTITUTIONAL SETTING

3.1 | Overview

Since 1981 the Chilean pension system has largely been a private and fully funded DC system based on individual personal accounts.[5] Participation in the system is mandatory with contribution rates of 10% of monthly earnings and with a cap on contributable income of around three times the average salary of all of those contributing to the system.[6] Currently, there are approximately 11 million active members in the system and 1.4 million pensioners. Pension schemes are managed by private firms called Pension Fund Managers (PFMs) that collect and invest contributions, manage the pension fund portfolio, administer accounts, and pay pensions where applicable. As of December 2019 PFMs managed $215.4 billion in assets, which represented 81.2% of Chilean gross domestic product.

In addition to mandatory DC pensions, there are two other distinctive elements of the Chilean pension system. First, there is a redistributive pillar that guarantees a basic pension to the poorest 60%

[4]Similar findings have been reported in home insurance choices. Specifically, customers prefer low deductibles even when their cost substantially exceed their expected value. This would be consistent with extremely high levels of risk aversion, which are difficult to reconcile with standard economic models (Sydnor, 2010).

[5]See Superintendencia de Pensiones (2010) for a fuller overview of the pensions system in Chile.

[6]This ceiling is indexed, and average real wages were about $3300 in 2019.

of the population from the age of 65. The redistributive pillar provides a noncontributory pension for individuals outside of the DC system called the Basic Solidarity Pension (BSP) which was equivalent to $165 per month in 2019, and is adjusted annually to take account of inflation. Second, there is a voluntary pillar that provides economic incentives in the form of tax exemptions and subsidies to encourage individuals to voluntarily save into these pension accounts over and above what they save in the compulsory DC part of the system.[7]

In Chile the legal retirement age is 60 for women and 65 for men, and it is at this point that individuals have the right to convert their accumulated pension wealth to regular payments through any of the available pension products. This right can be exercised at any time after meeting the legal retirement age but there is no mandatory age at which an individual must retire, that is, it is possible to work and accumulate a pension pot beyond the age of 60/65. Early retirement is also allowed within the system subject to meeting pension adequacy requirements as mandated by the government. However, due to increasingly stringent regulation surrounding the conditions for early retirement, the prevalence of early retirees has fallen over time, and the average retirement age has converged on the legal retirement age (Superintendencia de Pensiones, 2010).[8]

3.2 | Pension products

At retirement, individuals are offered three basic pension products: Phased withdrawal, annuities, and temporary income with a deferred annuity. The only option that does not have some sort of annuitization is phased withdrawal. For phased withdrawal, individuals keep their pension pot with their PFM and each month can withdraw an amount of money, with a maximum withdrawal enshrined in law and calculated according to regulatory parameters, including mortality expectations by age, sex, number of dependents, the expected return rate on pension fund investments, and the individual account balance. Under this scheme, the individual bears the longevity and market risks but maintains ownership of their accumulated pension assets. If an individual with this decumulation product were to die, then the remaining balance is used to provide a survivor pension, and in the absence of a legally defined survivor, then it becomes a legacy for inheritance purposes. Last, phased withdrawal is revocable, enabling a retiree to buy an annuity at any point over the course of their retirement with whatever assets remain in their pension pot, provided that any purchased annuity provides the legal minimum annuity payment.

As is common around the world the annuity option in Chile is an irrevocable contract whereby individuals transfer their accumulated pension assets to an insurance company in exchange for a monthly payment over their retired life. Annuities with a guarantee period are also available.[9]

[7]Around 18% of savers have such pensions.

[8]Before 2004 individuals could access early retirement if their accumulated pension assets allowed for a replacement rate of 50% of income with respect to their average salary over the previous 10 years, and a delivered a minimum pension of $145. Between 2004 and 2012 these requirements became more restrictive, with the replacement rate increasing to 70% and a minimum pension of $410. Consequently, the effective retirement age by 2019 increased from an average of 60.7 years for women and 60.9 years for men in 2004 to 61.4 years for women and 65.4 years for men.

[9]Here, the annuity contract guarantees that the regular pension payments will be made for a certain period even if the retiree dies, in which case these payments will be received by the named beneficiaries established in the set-up of the deferred annuity contract.

Under the temporary income with a deferred annuity option, individuals use part of their accumulated pension pot to buy a deferred annuity and hold the remaining balance with their PFM. During the deferral period, individuals can withdraw a monthly amount of money from their nonannuitized balance, up to a maximum of twice the value of the monthly annuity payment that will be received when the deferral period ends. The fraction of the account balance that is held with the PFM is valued to meet this requirement with the balance held by the PFM being fully disbursed at the point annuity payments commence. Retirees therefore obtain an initial period of greater liquidity, followed by annuity payments that are lower compared to those that would have been received from purchasing an annuity at retirement using all their accumulated pension assets.[10]

All annuities (simple annuities, guaranteed annuities, and deferred annuities) are subject to a minimum payment threshold linked to the level of the BSP at retirement. There are therefore no annuity payments below the BSP. In addition, all pension products include survivor benefits, and so the likelihood of having to pay survivor benefits is included in pricing, as are other key factors, for example, age, sex, account balance, and the legal beneficiaries of the individual.

3.3 | Pension consultation and offer system

The administration of this system is organized through a centralized quotation system called the Pension Consultation and Offer System, which is referred to by its Spanish acronym, SCOMP. Introduced in August of 2004, the objective of the system was to improve the transparency and reliability of the retirement process into decumulation. Through this electronic marketplace both individuals that are going to retire and the suppliers of retirement products are brought together in a transparent and efficient manner. Crucially, the use of SCOMP is mandatory for all individuals retiring who have accumulated pension assets that are sufficient to provide the legal minimum annuity. During the first half of 2019 33% of new retirees met the requirements to access SCOMP, while the remaining retirees could not buy any type of annuity as their accumulated assets were too small, and so had to take phased withdrawal.

To participate in the SCOMP system, when an individual reaches the legal retirement age or decides to retire, they complete a form to request pension products. This document allows the individual to request one, all, or several of the available pension products offered, for example, phased withdrawal and a simple annuity. Any guarantee periods or deferral periods must be specified, and up to three options can be requested, that is, an individual can make requests for annuities with guarantee periods of 10, 15, and 20 years and deferral periods of 1, 2, and 3 years, and companies will combine both conditions in their offers. Here, the offers individuals receive are exogenously determined, and so making a product request does not mean that an offer will be received from all annuity providers in the market. The request form is then sent to all insurance companies and PFMs, who subsequently send their pension offers back into the SCOMP system, which collects and collates all offers in an official document called the "*offers certificate*," which is sent back to the individual. Once individuals receive their offers certificate,

[10]It is worth noting that there is the option to take a lump sum if an individual has enough pension assets, but very few retirees meet the regulatory requirements to do so.

they can take one of the following actions: accept an offer, make a new request (up to a maximum of three), ask an insurance company for an offer improvement (known as an "external offer"), or defer retiring.[11]

It is worth noting that Chile has historically high rates of annuitization, with 60%–70% of those retiring with sufficient account balances to afford at least the minimum annuity, proceeding to do so. As in other annuity markets around the world, a large portion of the annuities sold in Chile have a guarantee period, with more than 80% of sold annuities having this product feature. This aspect of the Chilean system is also relatively stable over time, with typical guarantee periods of between 10 and 20 years. More recently, products offering a temporary income with a deferred annuity have experienced rapid growth and in the first half of 2019 these products represented almost 63% of total annuity purchases.[12]

3.4 | Rating requirements for annuity providers

Chilean insurance law requires insurance companies in the annuity market to be rated by at least two different and independent credit rating agencies which, in turn, must be authorized to operate and be listed on a public register.

The rating process determines how solvent an insurance company is in the medium and long term, particularly regarding its ability to meet its payment obligations to policyholders. This involves assessing the credit quality and quantity of fixed income investments, adequacy of reserves, quality and quantity of reinsurance, return rate in prior years, debt levels of the firm, and level of operations in relation to the insurers equity, currency risk management, the duration of liabilities, adjustment clauses, and the skills and experience of the management team.

Credit risk agencies assign insurance companies ratings ranging from AAA, AA, A, BBB, BB, B, C, and D, with AAA being of the highest quality, while category E is assigned when there is not enough information to rate an insurer. These categories can also be modified by the subscript plus (+) or minus (−), where AA+ would indicate a lower level of insolvency risk than AA− for example. Only those insurance companies with a risk rating of BB or better are allowed to offer annuities in the Chilean market. Accordingly, if an insurance company is rated below BB it cannot offer annuities, while if the credit rating of an insurer deteriorates and falls below BB, it must cease offering annuities with immediate effect.

3.5 | Government guarantees and default by annuity providers

In the event of default by an insurance company, the government partially guarantees annuity payments. This guarantee covers 100% of the pension up to the minimum pension payment and 75% of the pension value above that level, up to a maximum amount per month. Specifically,

[11]Individuals can request the services of an insurance broker or an independent pension advisor if they wish. The fee for this support and advice is taken as a percentage of the retiree's account balance, with a maximum absolute fee that is enshrined in law.

[12]Author calculations based on SCOMP database.

$$PG_i = \min\{P_{Min} + 0.75(P_i - P_{Min}), MMP\},$$

where PG_i is the monthly pension payment that individual i will receive from the government if the guarantee comes into effect due to the insolvency of an insurance company; P_{Min} is an exogenous parameter that stands for the minimum pension; P_i is the annuity payment originally promised to an individual i by the bankrupt insurance company; and MMP is the maximum monthly payment with the maximum guaranteed amount, which corresponds to around $2000 a month in 2019.

In light of the above, a coverage rate of the annuity provider's default risk can be calculated for the individual i as PG_i/P_i, which indicates the pay-off fraction that the individual will receive in the event of default by the insurance company. This coverage rate ranges between 77% and 100% for those individuals whose PG_i is below the maximum monthly payment, while it is less than 77% for those individuals whose PG_i exceeds the maximum.

4 | REFORMS, PREDICTIONS, AND VARIABLES OF INTEREST

In July 2009 the minimum pension value for determining the government guarantee in case of default was reduced significantly by about 30%. This shift in the magnitude of the government guarantee was due to structural reform to the redistributive pillar of the Chilean pension system that took place in July 2008.

This reform significantly changed the eligibility rules for noncontributory pensions and the progressivity of the benefits. However, it was not until the year after that the minimum pension parameter was updated in the formula about regulatory calculation that determines the level of payment provided by the guarantee in the event of provider default. This change therefore affected all annuity contracts signed after July 2009.[13]

Considering all the above, from a rational perspective, the drop in individuals' coverage rate should make the risk rating of the insurance company a more salient attribute in their decision-making. Therefore, when faced with a trade-off between provider risk and the value of the monthly annuity payment, the relative importance of the value of the annuity payment will decrease and so individuals will be more willing to accept a lower monthly payment to go with a lower-risk provider. Accordingly, a rational economic framework predicts a negative relation between coverage rate and pension sacrifice, that is, individuals buying annuities before the change in the minimum pension should, on average, sacrifice less pension value to decrease the default risk of the provider than those making their annuity selection after the change. Equivalently, if individuals are behaving in a manner consistent with a model of economic rationality, their willingness to pay to decrease provider risk is expected to be higher after the reform when they are more exposed to insurer default risk.

If this is not the case and, for example, no relationship is found between coverage rates and pension sacrifice, it would be indicative of the possibility that individuals do not incorporate their exposure to provider default risk into their decisions.

[13]It should be noted that there have been other two changes in the minimum pension over time; it increased by 10% in December 2006 and in January 2017. However, these have been retroactive, affecting the stock of pensioners instead of the flow of new pensioners, that is, individuals retiring before the change will have a coverage rate consistent with the minimum pension after the change if the insurance company goes to bankruptcy after the date of change.

As we are interested in studying the effect of individuals' sensitivity to their pension sacrifice risk exposure, a key explanatory variable is the coverage rate of the guarantee as a measure of risk exposure. This is defined as the pay-off fraction guaranteed by the government in case of default by the annuity provider, that is, the pension payment that the individual will receive if the guarantee comes into effect, as calculated in Section 3.5, divided by the annuity payment promised to the individual by the company selected on the chosen offer.

In addition, as a measure of pension sacrifice we consider a Sacrifice Indicator, that is, a dummy variable that takes a value of 1 if the individual does not choose the best value efficient offer and 0 otherwise.

5 | DATA AND SUMMARY STATISTICS

Our main database contains information on individuals who bought an annuity using SCOMP between August 2004 and June 2019. However, to avoid capturing information about other modifications to the minimum pension parameter,[14] our final sample includes only those individuals retiring between January 2007 and December 2016.

We further restrict our sample to those individuals who accepted an efficient offer in terms of pension value and the default risk of the insurance company. In other words, there was no other offer that simultaneously presented a higher value and a lower level of risk. We also consider only individuals who received at least two efficient offers. In addition, we exclude those whose pensions are above the maximum monthly payment of the guarantee as these are outliers in terms of the coverage rate. As the use of the SCOMP system is restricted to those individuals who can fund the minimum pension, higher levels of the minimum pension prevent some individuals from accessing annuities. For this reason, we consider only those individuals whose accumulated resources are sufficient to fund the "maximum" minimum pension, and so all individuals in our entire sample could have bought annuities under any of the observed minimum pension values.

Taking account of all of this, we end up with a final sample that allows us to examine the actual decisions of 80,950 individuals who bought an annuity using SCOMP between January 2007 and December 2016. Table 1a reports summary statistics for the whole sample period, and for before and after the reform date.[15]

In the full sample, 44% of individuals are female, 66% are married,[16] 18% have at least one dependent child and the average retirement age is 63 years old.[17] In addition, 15% of new retirees have the right to withdraw a partial lump sum, 78% contract an intermediary, and the

[14]Considering that these additional modifications (December 2006 and January 2017) acted retroactively, this avoids capturing behavioral changes in the margin driven by misinformed individuals.

[15]Supporting Information Table A1a presents summary statistics for the subsamples of individuals retiring within a 12-month window and a 24-month window around the reform date.

[16]The change observed in the proportion of married individuals pre- and postreform does not reflect a change in individuals' marital status but in the obligation to report it. Until 2008, survivor benefits were only included in the pension of the husband, whereas after that date, survivor benefits were included in both spouses' pensions. Consequently, for women, reporting their marital status was voluntary until 2008 and mandatory after that date.

[17]In Chile, a dependent child is up to 18 years old or 24 years old if they are undertaking university study.

TABLE 1a Summary statistics—Demographics, choices, and offers.

Full sample	All	By retirement date	
		Before reform	After reform
Panel A: Demographic characteristics			
Female	0.44	0.47	0.43
Married	0.66	0.51	0.69
Dependent children	0.18	0.21	0.17
Age	63.0	62.2	63.3
Panel B: Pension characteristics			
Lump sum right	0.15	0.18	0.14
Independent advisor (A)	0.41	0.57	0.36
Insurance broker (B)	0.38	0.29	0.40
Intermediary (A + B)	0.78	0.86	0.76
Annuity value (USD)	531.9	547.4	527.8
Panel C: Requests and selected product characteristics			
Products requested	9.01	7.87	9.32
Guarantee period (years)	11.15	10.74	11.27
Deferral period (years)	0.68	0.48	0.74
External offer	0.89	0.89	0.89
Panel D: Set of offers characteristics			
Number of efficient offers	2.67	2.59	2.70
Number of offers	12.35	11.70	12.53
Risk level of the best value offer	4.54	4.23	4.63
Average risk of offers	3.57	3.42	3.61
Standard deviation risk of offers	1.86	1.41	1.98
Standard deviation value offers	0.20	0.27	0.18
Number of observations	80,950	17,077	63,873

Note: To compute the variables risk level of the best value offer, average risk of offers, standard deviation risk of offers, and standard deviation of value offers numbers from 1 to 10 are assigned to ratings from AA+ (best rating observed) to BB+ (least rating acceptable). Also, those are calculated within the offers of the selected product.

average monthly pension is just over $530. Also, in the full sample, individuals ask for an average of nine different pension products. For the pension products that individuals selected, the average guarantee period is just over 11 years, the average deferral period is less than a year, and 89% of the annuities accepted are external offers, that is, offers received after the *offers certificate* was issued in response to offer-improvement requests. Finally, individuals receive on average 2.7 efficient offers in terms of the pension value and default risk of the provider, out of an average of 12 offers in total. The offers that present the highest pension value, on average, come from companies rated between AA− (level 4) and A+ (level 5), while the average risk of all offers received is between AA (level 3) and AA− (level 4).

TABLE 1b Summary statistics—Coverage rate and pension sacrifice.

	Mean	Median	SD	p5	p95	*N*
Coverage rate						
Total	85.07	84.46	4.93	77.97	93.08	80,950
Before	87.34	86.45	5.89	78.82	98.03	17,077
After	84.46	83.99	4.44	77.82	92.18	63,873
Sacrifice indicator (0–1)[a]						
Total	0.31	0.00	0.44	0.00	1.00	80,950
Before	0.23	0.00	0.40	0.00	1.00	17,077
After	0.33	0.00	0.45	0.00	1.00	63,873

[a]Dummy variable that takes value 1 if the individual does not choose the best value offer.

When comparing individuals retiring before and after the reform date, the data shows that after the reform there are fewer females, more married individuals, and a lower prevalence of dependent children. In addition, the use of intermediaries decreases substantially, and annuity values decline. Individuals also tend to ask for more pension products and accept annuities with substantially longer deferral periods. Finally, in looking at the level of dispersion of the offers received after the reform, it is higher in terms of risk but lower in terms of value.

Summary statistics for the full sample of our key explanatory variable, that is, coverage rate, and the pension sacrifice indicator are reported in Table 1b.[18]

From Table 1b the average coverage rate of the government guarantee is 85%. As such, in the case of default by the insurance company then individuals would receive, on average, 85% of their contracted annuity from the government.

With respect to pension sacrifice, 31% of individuals do sacrifice some pension value to get a lower-risk annuity provider. The average pension sacrifice tends to be larger for those retiring after the reform date.

On the supply side, we also collect information about the insurance companies in the annuity market. Specifically, for each period and company, we collected data on insurance premiums received for both annuities and all insurance policies, number of branches, number of complaints received by the regulator, and the size of the sales force, that is, the number of brokers focused on selling annuities.

This information is matched with the SCOMP database, so individuals' alternatives are associated not only to a value and a risk rating but also to the characteristics of the company making the offer at the individual's retirement date.

In looking at the attributes of the offers received in Table 1c, chosen offers are substantially closer to the best value offer and are slightly less risky than the other offers received. In addition, chosen offers tend to come from companies that, over the 12 months preceding the retirement of the individual, had, on average, relatively more insurance brokers, larger market share, a greater number of branches, but more formal complaints.

[18]Analogous summary statistics for the subsample of individuals retiring within a 24-month window around the reform date are available in Supporting Information Table A1b.

TABLE 1c Summary statistics—Attributes of the offers received.

	All offers		Chosen offers		No chosen offers	
	Mean	SD	Mean	SD	Mean	SD
Value offered	0.024	0.022	0.0045	0.008	0.026	0.022
Risk rating	3.6	1.9	3.5	1.8	3.6	1.9
Number of brokers	34.9	35.4	42.2	35.9	34.2	35.3
Market share	0.07	0.04	0.08	0.04	0.07	0.04
Number of branches	15.8	8.6	17.1	8.0	15.7	8.7
Number of complaints	54.0	44.4	61.3	45.6	53.3	44.3
Number of observations	323,159		27,384		295,775	

Note: Value offered is calculated as the percentage difference between the best value offer and each offer of the set. To compute risk rating, numbers from 1 to 10 are assigned to ratings from AA+ (best observed) to BB+ (least rating acceptable). Number of brokers, branches, and complaints are calculated as an average over the 12 months preceding an individual's retirement. Market share is the participation of the company on the annual annuity premiums as of December the year before the retirement of the individual.

6 | METHODS

6.1 | RD design

To empirically examine whether individuals are sensitive to actual annuity providers' default risk, we apply a fuzzy RD design.[19] There are two reasons why the relationship between individuals' coverage rate in case of provider default and pension sacrifice is endogenous and so cannot be directly estimated necessitating an RD approach. First, offers with higher pay-outs, that also involve less coverage, tend to come from riskier insurers, which implies a lower sacrifice. Second, the coverage level depends on individuals' pension value, which in turn reflects other individuals' characteristics that potentially affect their choices, for example, risk aversion. For this reason, we use the discontinuity in the minimum pension as an instrument for an individual's coverage rate in case of provider default.

To implement this, we estimate a two-step procedure in which the excluded instrument is a dummy variable equal to one for individuals retiring after the change:

$$D_i = \begin{cases} 1 & \text{if } x_i \geq \text{July } 2009, \\ 0 & \text{if } x_i < \text{July } 2009. \end{cases}$$

Following a parametric approach, we estimate the effect of interest using the model described below:

$$\text{First stage: } Cov_i = \gamma_1 D_i + \gamma_2 x_i + \gamma_3 x_i D_i + \kappa Z_i + \mu_i, \quad (1)$$

[19]In this case, time is the running variable and treatment begins at a particular threshold in time. This approach is considered an adaptation of the standard RD framework called Regression Discontinuity in Time (RDiT) and has been implemented in recent empirical work from several economic fields (Hausman & Rapson, 2018).

$$\text{Second stage: } Y_i = \beta_1 \hat{Cov}_i + \beta_2 x_i + \beta_3 x_i D_i + \rho Z_i + \varepsilon_i, \quad (2)$$

where Cov_i is the pay-off fraction guaranteed by the government in case of default of the annuity provider, Y_i is the outcome of interest, that is, the pension sacrifice indicator, x_i is the retirement date (month–year) and Z_i is a vector of control variables[20] that includes: individuals' characteristics, the characteristics of the selected pension product, the characteristics of the offers, and fixed effects by annuity value.[21] It is worth noting that this is a within-product analysis, as pension sacrifice is defined within the offers of the selected product.

The basic assumption of this approach is that all potentially relevant variables at either side of the threshold are continuous except for the treatment, which is received only for individuals on one side of the discontinuity.

On the supply side, we cannot rule out the possibility that insurance companies change the characteristics of the offers they make because of the policy reform, for example, riskier insurers may start making more aggressive offers. However, in this setting, all relevant characteristics of the offers are observables, and therefore we can capture their effect by controlling for them. For this reason, we consider a number of variables that describe the set of offers received by individuals. Specifically, we control for the number of efficient offers received, number of total offers received, risk rating of the company offering the best value offer, average risk rating of the companies making offers, standard deviation of the risk of the companies involved, and standard deviation of the pension values offered. Additionally, no material changes are observed in those variables at the threshold.[22]

Another potential threat to identification from changes on the supply side comes from the fact that we restrict the sample to those individuals receiving at least two efficient offers. Then we assume that the set of individuals receiving two efficient offers does not change systematically and concurrently with the policy reform. To explore this, we analyze the evolution of the proportion of individuals receiving two efficient offers. Reassuringly, this does not change at the time of policy reform.[23]

On the demand side, although we capture demographic changes by controlling for a set of individuals' characteristics, unobserved changes (at the threshold) related to the choice of insurer or individuals' ability to make good/bad decisions represent a potential risk to identification. An important concern in this context is whether individuals could manipulate their probability to be assigned to the treatment, in other words, whether some individuals (e.g., the best decision makers) moved forward their retirement date to obtain a higher default insurance. However, no changes are observed in the number of individuals retiring each month around the reform date.[24]

Finally, it is important to note that this analysis assumes that default coverage does not affect product selection, but that it may affect provider selection within a product. This assumption is supported by the fact that coverage at the product level is implicit in the annuity

[20]It has been pointed out that, in the RDiT context, unobservable factors correlated with the running variable may have discontinuous impacts on the potential outcome. Then, the inclusion of covariates may be needed to prevent bias, rather than simply to improve precision as in standard RD frameworks (Hausman & Rapson, 2018).

[21]For more details on these variables, see Table 1a.

[22]See Supporting Information Figure A1, Panels A–F.

[23]See Supporting Information Figure A1, Panel G.

[24]See Supporting Information Figure A1, Panel H.

value, with the annuity value itself being the attribute of interest. For example, when comparing a 20-year payment-protected annuity to a simple annuity, the monthly payment of the payment-protected annuity is lower reflecting the cost of payment protection. Individuals will therefore consider the costs and benefits of payment protection to decide between products. However, that individual will not accept a reduced payment simply to obtain higher default coverage, as they do not face that trade-off at a product level. Rather, they face that choice when selecting the product provider, and it is the provider that has an identified level of default risk. In other words, we assume that individuals choose a product first and then decide which offer, from what company, they prefer. It is at this point that they will decide if they will sacrifice any pension value and if so, by how much.

Under this assumption, the reform affects the extent of coverage faced within the selected product, which is expected to affect the choice of provider (e.g., if the government offers a 100% guarantee, then no pension sacrifice is expected) and this effect can be captured by the RD design described in this section.

6.2 | Mixed logit

The analysis above allows us to assess whether a causal relation exists between accepting lower annuity payments from lower-risk providers and the extent that an individual is exposed to default risk. Then, it focuses on a specific outcome of individuals' choice process, examining those variables that are financially relevant for determining the attractiveness of an annuity offer, that is, value of the pension at retirement and risk rating of the annuity provider.

In this section we undertake an additional analysis that seeks to model the underlying individual decision process, including other provider characteristics that individuals may consider when making their final decision. Specifically, we implement mixed logit models to examine individuals' preferences for different insurance company characteristics. In this case, to identify how individuals' choices react to changes in the default insurance coverage, we compare individuals' preferences for each provider attribute between those who retired before the change in the minimum pension and those retiring after. For this analysis, it is important to note that the effect of interest remains the policy discontinuity, that is, the change in the minimum pension. As well as this, we assume that both groups, that is, those retiring before the change in minimum pension and those retiring after are, on average, comparable. In doing so, we can utilize the benefits of the mixed logit as a model with a structural interpretation, but this comes at the cost of having more strict assumptions than those in our primary analysis in Section 1.

The mixed logit model is considered an extension of the conditional logit model (McFadden, 1973) as it also aims to model a decision with multiple alternatives and multiple attributes of these alternatives. However, in contrast to the conditional logit model, the mixed logit model allows a random parameter specification, so the estimated effects of the alternatives' attributes have a mean and a standard deviation. In other words, the mixed logit model accommodates the presence of heterogeneity in individuals' preferences, which is something the conditional logit model does not do. In addition, the mixed logit model recognizes that unobserved information that is relevant for decision-making but unknown to

the researcher can induce correlation across the alternatives. Thus, unlike the conditional logit model, the independence of irrelevant alternatives (the IIA assumption) is not required.

In this context, it is assumed that individuals at retirement face a set of annuity alternatives from different insurance companies, assess all of them, and choose those providing the highest utility. Following Revelt and Train (1998), we observe the choices of N decision-makers that face a choice among J alternatives. The utility of individual n from alternative j is given by

$$U_{nj} = \beta_n' x_{nj} + \varepsilon_{nj}, \tag{3}$$

where β_n is a vector of coefficients that vary over decision-makers, that is, individual-specific sets of preferences, x_{nj} is a vector of attributes observed by individual n for alternative j, and ε_{nj} is a random term, which is assumed to be an IID extreme value.

The vector of explanatory variables includes the value of the annuity as a proxy for cost. It is calculated as the percentage difference between the best value offer and each offer of the set and can therefore be interpreted as pension killed in the pursuit of improving other attribute(s) of the annuity. In addition, this vector considers the characteristics of the insurance company making the annuity offer,[25] such as risk rating, market share, number of branches, number of complaints received, and size of the sales force as described above. In some specifications we also include a variable that indicates whether or not the broker hired by the individual works for the company that makes the offer.

We assume that the parameters β_n of all attributes of the offers, except the cost are random and that they are normally distributed across individuals. Then, for any attribute k:

$$\beta_{nk} = \beta_k + \sigma_k u_{nk}, \tag{4}$$

The parameter u_{nk} denotes the individual heterogeneity, while σ_k is the standard deviation of β_{nk} around the mean β_k and the parameter of the cost proxy, value offered, is fixed.[26]

Crucially, when a proxy of cost is included as an attribute, it is possible to use the random coefficients to derive estimates of willingness to pay for the attributes.

$$WTP_k = -\frac{\beta_k}{\beta_{cost}}, \tag{5}$$

where WTP_k represents individuals' marginal willingness to pay for attribute k, and it is normally distributed, as coefficient k is normally distributed and the cost coefficient is fixed.

Considering the utility function defined above, and conditional on β_n, the probability of individual n choosing alternative i is specified as

[25]As individuals retire and move into decumulation just once in their lifetime, we cannot observe repeated choices and so, by definition, individuals' characteristics will not vary within the unit of analysis. Thus, their effects are saturated, and cannot be incorporated in the analysis as explanatory variables.

[26]Fixing the cost coefficient has several advantages; it ensures that the coefficient has the correct sign, implies that the distribution of willingness to pay for the remaining attributes follows the same distribution as the attribute coefficients, and helps empirical identification (Hole, 2008). Moreover, it is commonplace within extant studies to take this approach (Goett et al., 2000; Gutsche & Ziegler, 2019; Hensher et al., 2005).

$$L_{ni}(\beta) = \frac{\exp(\beta' x_{ni})}{\sum_{j=1}^{J} \exp(\beta' x_{nj})}. \tag{6}$$

However, as β_n is not known then it is necessary to obtain the unconditional choice probability, which is given by

$$P_{ni} = \int L_{ni}(\beta) f(\beta|\theta)\, d\beta. \tag{7}$$

That is, the expected value of $L_{ni}(\beta)$ is integrated over all possible values of β and weighted by the density of β. Then, the log-likelihood is given by $LL(\theta) = \sum_{n=1}^{N} \ln P_{ni}$. However, this cannot be solved analytically and so it is not possible to use a Maximum likelihood estimation, instead it is approximated through simulation. The simulated log-likelihood is calculated as

$$SLL(\theta) = \sum_{n=1}^{N} \ln \left\{ \frac{1}{R} \sum_{r=1}^{R} L_{ni}(\beta^r) \right\}, \tag{8}$$

where R is the number of draws and β^r is the rth draw from $f(\beta \mid \theta)$. Then, the model is estimated by using maximum simulated likelihood (see Train, 2009).

Here, to determine whether individuals' willingness to pay for getting a lower-risk provider increases when the coverage of the government guarantee is lower, we estimate mixed logit models for individuals retiring right before and after the policy reform and then compare the results obtained. Thus, as we are using the same discontinuity to identify the effect of interest, the same considerations discussed in Section 6.1 about potential threats to identification are valid.

7 | EMPIRICAL RESULTS

7.1 | RD results

We first use the change in the minimum pension as an instrument for individuals' risk exposure to providers to explore its effect on pension sacrifice and whether we observe changes in annuity providers to those with a lower probability of default. Table 2 reports RD estimates of the second stage of the two-step procedure described by Equations (1) and (2).[27]

As shown in Table 2, the effect of the coverage rate on the decision to sacrifice pension value is statistically indistinguishable from zero and this is regardless of which window around the break is considered. This suggests that individuals, on average, are not including information about provider default risk and government guarantees in their decumulation decisions.[28]

[27]For more details on the results of the first stage of these models see Supporting Information Table A2.

[28]Similar results are found using a nonparametric approach (see Supporting Information Table A3). In addition, our parametric approach assumes a linear time trend. To verify the robustness of results to this assumption, we replicate the analysis using different polynomial time trends and results do not substantially change. Results of this robustness check are available in Supporting Information Table A4.

TABLE 2 Regression discontinuity estimates—Second stage.

	Pension sacrifice indicator (0/1)
Panel A: Full sample	
Coverage	0.000
	(0.002)
N	80,950
R^2	0.406
Panel B: 12-month window	
Coverage	−0.001
	(0.005)
N	12,597
R^2	0.366
Panel C: 24-month window	
Coverage	0.000
	(0.003)
N	27,270
R^2	0.347

Note: This table reports regression discontinuity estimates of the second stage of the two-step procedure described by Equations (1) and (2). Standard errors (displayed in parentheses) are robust to the presence of arbitrary heteroskedasticity. All models include additional controls (variables in Table 1a and fixed effects by annuity value).

*Significant at 10%; **significant at 5%; ***significant at 1%.

To analyze whether individuals' sensitivity to the coverage rate differs by income level, we re-estimate the models using different subsamples. We define "low," "medium," and "high" pension levels, by sorting individuals into terciles by annuity value of the accepted offer. Table 3 reports RD estimates of the second stage of the two-step procedure described by Equations (1) and (2) splitting the sample by pension level and using a 24-month window.

When the sample is split by level of annuity payment, individuals with a low pension level (first tercile of the distribution) show a positive effect of the coverage rate on pension sacrifice. By contrast, a negative relation between coverage rate and pension sacrifice is observed at higher levels of pension, which is consistent with a rational perspective. This suggests that poor decision-making is more prevalent in lower-income individuals, who sacrifice a higher proportion of their pensions to get a lower-risk provider. However, these individuals with lower pension values would, in the event of provider default, be expected to receive most if not all of their pension as a result of the government guarantees that are in operation.

7.2 | Mixed logit results

We extend our analysis by incorporating attributes of offers, and other insurance company characteristics, apart from the provider risk rating, that could potentially influence an individual's preference for different annuity offers. This allows us to examine how the reform

TABLE 3 Regression discontinuity (RD) analysis by pension level—24-Month window.

	Pension sacrifice indicator (0/1)
Panel A: Low pension level	
Coverage	0.009**
	(0.004)
N	8956
R^2	0.347
Panel B: Medium pension level	
Coverage	−0.030***
	(0.007)
N	8961
R^2	0.364
Panel C: High pension level	
Coverage	−0.025**
	(0.010)
N	9353
R^2	0.383

Note: This table reports RD estimates of the second stage of the two-step procedure described by Equations (1) and (2) splitting the sample by pension level and using a 24-month window. To define "low," "medium," and "high" pension levels, individuals are sorted into terciles by annuity value of the accepted offer. Standard errors (displayed in parentheses) are robust to the presence of arbitrary heteroskedasticity. All models include additional controls (variables in Table 1a and fixed effects by annuity value).

*Significant at 10%; **significant at 5%; ***significant at 1%.

affects individuals' willingness to pay for lowering the risk of the annuity provider after controlling for individuals' preferences for other attributes of the annuity offers and providers.

Table 4 presents mixed logit estimates for annuity offer selection. In this analysis, we consider the decisions of individuals retiring within a 24-month window around the reform to the BSP and split the sample by retirement date, separating those individuals who retired before the change in the minimum pension, and those retiring after.

Although the magnitudes of the coefficients are not directly interpretable, the signs of the coefficients show the direction of the average preferences. In addition, the standard deviation of the coefficients indicates how heterogeneous individuals' preferences are for each attribute.

In specification (1), only the attributes directly stated in the offer certificate are considered, that is, value and risk, while specification (2) adds other provider characteristics. Finally, specification (3) includes an additional variable that marks the broker's company, for those individuals using this type of intermediary.

In all specifications, a higher value offered, and a lower risk of the provider are preferred by individuals. However, the standard deviation of the risk coefficient is relatively high, and similar in magnitude to the coefficient itself, indicating that there is significant heterogeneity in individual preferences. In specifications (2) and (3) the coefficients are positive on market share, number of branches, and the size of sales force and so, as expected, individuals tend to

TABLE 4 Mixed logit estimates—Annuity offer selection, before and after the reform.

		(1)		(2)		(3)	
Variable	**Parameter**	**Before**	**After**	**Before**	**After**	**Before**	**After**
Value offered	Mean coeff.	344.7***	351.5***	330.3***	310.9***	501.4***	609.9***
Risk rating	Mean coeff.	−2.3***	−2.4***	−1.6***	−1.6***	−1.7***	−1.9***
	SD	1.96	2.33	1.36	1.41	1.41	1.57
Number of brokers	Mean coeff.			0.009***	0.001	0.008***	−0.005***
	SD			0.00	0.00	0.04	0.03
Market share	Mean coeff.			2.7***	11.8***	−0.1	10.3***
	SD			0.62	0.1	1.61	12.08
Number of branches	Mean coeff.			0.04***	0.05***	0.032***	0.075***
	SD			0.09	0.07	0.07	0.11
Number of complaints	Mean coeff.			−0.001**	−0.006***	0.003***	−0.006***
	SD			0.00	0.00	0.00	0.01
Company's broker	Mean coeff.					15.8***	23.4***
	SD					8.86	14.49
Log-likelihood		−14,807	−17,873	−14,501	−16,670	−10,218	−10,870
Number of observations		169,914	153,245	169,914	139,478	169,914	139,478
Number of individuals		14,268	13,116	14,268	13,116	14,268	13,116

Note: This table shows the results of mixed logit models with normally distributed coefficients for all the variables except the variable "value offered" which does not vary. Value offered is calculated as the percentage difference between the best value offer and each offer of the set, and therefore can be interpreted as a cost variable. Company's broker is an indicator variable that takes value 1 if the broker hired by the individual works for the company that makes the offer and zero otherwise. The categories "before" and "after" indicate whether individuals' pension date was before or after the change in the minimum pension (July 2009).

*Significant at 10%; **significant at 5%; ***significant at 1%.

prefer larger insurance companies with a bigger sales force and a greater number of branches, while also preferring providers with lower levels of customer complaints.

It should be noted that the comparison across attributes is limited in this setting as coefficients are measured in different units. However, as the cost variable is a fixed parameter in these specifications, it is possible to calculate a willingness to pay measure by dividing the coefficient of the attribute by the cost coefficient, as described in Equation (5).

Table 5 presents willingness to pay estimates using Equation (5). Here, attributes that increase (decrease) the value of the annuity will show a positive (negative) sign on the willingness to pay estimate. Therefore, a positive value can be interpreted as how much the individual is willing to pay for an increase in an attribute, that is, how much an individual is willing to pay to go to a larger firm, while a negative value would indicate how much the individual requires as compensation to accept an increase in a given attribute, that is, how much an individual would need to be compensated via an increased annuity payment to go with a provider with a higher number of complaints.

TABLE 5 Willingness to pay estimates, before and after the reform.

	(1)		(2)		(3)	
	Before (%)	**After (%)**	**Before (%)**	**After (%)**	**Before (%)**	**After (%)**
Risk rating						
WTP	−0.66	−0.69	−0.48	−0.51	−0.33	−0.30
Difference	−0.033*		−0.031		0.030	
Number of brokers						
WTP			0.003	0.000	0.0015	−0.001
Difference			−0.003***		−0.002***	
Market share						
WTP			0.83	3.78	−0.02	1.69
Difference			2.95***		1.71***	
Number of branches						
WTP			0.01	0.02	0.01	0.01
Difference			0.004*		0.006***	
Number of complaints						
WTP			−0.000	−0.002	0.0007	−0.0009
Difference			−0.002***		−0.002***	
Company's broker						
WTP					3.14	3.83
Difference					0.691***	

Note: The categories "before" and "after" indicate whether individuals' pension date was before or after the change in the minimum pension (July 2009). These willingness-to-pay estimates are computed based on mixed logit models analogous to those presented in Table 2 but splitting the sample by individuals' pension date (coefficients are omitted).

*Significant at 10%; **significant at 5%; ***significant at 1%.

In general terms, from specification (1) we can see that individuals are, on average, willing to reduce their annuity value by about 0.68% to go with a lower-risk insurance company. In specifications (2) and (3), when more attributes are included, this indicator decreases substantially, as other attributes such as the size of the company and broker's affiliation are also valued by individuals.

Regarding the effect of the reform, in specification (1), we observe a small significant increase in the required compensation for accepting a higher-risk provider after the reform, which is consistent with the actions of a rational actor. However, when more attributes are included, in specifications (2) and (3), the difference before and after the reform is no longer statistically significant. This suggests that individuals' willingness to pay for lowering risk is not substantially affected by the reform and so their sensitivity to actual risk exposure is rather limited.

By contrast, in specification (2), a strong and statistically significant positive effect of the reform is observed in individuals' willingness to pay for larger annuity providers. In addition,

when the broker's affiliation is considered in specification (3) there is also a sizeable and significant increase in the value that individuals give to broker recommendations.

Taken together, these results indicate that after the reform, individuals prefer annuities from larger insurance companies and rely more on brokers' recommendations, while there are no changes in the importance that they attach to the formal risk rating of the insurance company.

Finally, we split the sample by annuity value level to examine how individuals' responses vary by income. Table 6 shows individuals' willingness to pay for risk ratings, before and after the reform by level of annuity value. As above, we define "low," "medium," and "high" pension levels, by sorting individuals into terciles by the annuity value of the accepted offer.

Looking at individuals' willingness to pay for risk in the full sample, this attribute is relatively more important for individuals with higher pension levels in all specifications. This is consistent with the fact that, all else being equal, they are entitled to a lower coverage rate in case of default. However, it could also be as a result of individual preferences that correlate with their income level. Thus, to examine whether their willingness to pay for getting a lower-risk provider increases when the coverage of the government guarantee is lower, it is necessary to compare this before and after the exogenous change in the minimum pension.

In that respect, across all specifications, individuals with the highest annuity value are the only group that exhibits a rational response to the reform. This is consistent with the results obtained from the RD framework and shows that high-income individuals are sensitive to their actual exposure to provider default risk, while low-income retirees are not able to properly incorporate this information into their decisions.

TABLE 6 Willingness to pay for risk rating, before and after the reform—By pension level.

			Reform		
Specification	**Annuity value**	**Full sample (%)**	**Before (%)**	**After (%)**	**Difference (%)**
(1)	Low	−0.56	−0.57	−0.56	0.01
	Medium	−0.63	−0.65	−0.59	0.06**
	High	−0.93	−0.84	−1.02	−0.18***
(2)	Low	−0.28	−0.31	−0.21	0.09***
	Medium	−0.49	−0.53	−0.47	0.05
	High	−0.80	−0.74	−0.90	−0.17***
(3)	Low	−0.23	−0.29	−0.18	0.11***
	Medium	−0.34	−0.38	−0.34	0.03
	High	−0.55	−0.49	−0.60	−0.11**

Note: To define "low," "medium," and "high" pension levels, individuals are sorted into terciles by the annuity value of the accepted offer.

*Significant at 10%

**significant at 5%

***significant at 1%.

8 | ECONOMIC IMPACTS

In looking at our results, it is reasonable to assume that differences in cumulative default probabilities between, for example, an "AA+" firm and a "BB+" firm are small or economically trivial. However, there are two aspects in which our findings are neither small or economically inconsequential. The first is at the individual level. There is a well-established theoretical underpinning of research into decumulation that even a modest perceived risk of default can reduce annuitization (Li et al., 2021). There is also experimental evidence confirming that insurance with default risk is extremely unattractive to most individuals, and as such their willingness to pay for insurance decreases sharply in the presence of even small default probabilities as compared to a risk-free insurance contract (Zimmer et al., 2009, 2018). The second aspect where this is not trivial is at the macro level, and so even small shifts in annuitization rates significantly reduce aggregate welfare (Li et al., 2021). As such, our empirical as opposed to theoretical evidence shows that retirees are willing to forego some level of income in retirement to move to a provider with a lower probability of default, even in the presence of government guarantees.

To help illustrate the consequential nature of this change, below we present a distributional analysis. These highlight the extent of the sacrifice in dollar amounts and as a percentage reduction in the annuity received. It is also worth noting that any reduction is a per annum loss, and so the cumulative loss over the retired life of an individual is significant.

In looking at Figure 3, at first glance, the dollar amounts killed are fairly low being less than $100 per annum. However, it is also clear that around 5% of the sample are sacrificing more than $250 per annum. Where this becomes more acute is when we look at the amount of the annuity that is being killed and so these small dollar amounts are actually between 1.04% and 1.22% of the annuity value with then most extreme cases showing between 18.30% and 22.95% of the annuity being killed (see Table 7). As the amounts presented are annual, the cumulative amount of sacrifice over the retired life of the retiree will be considerable.

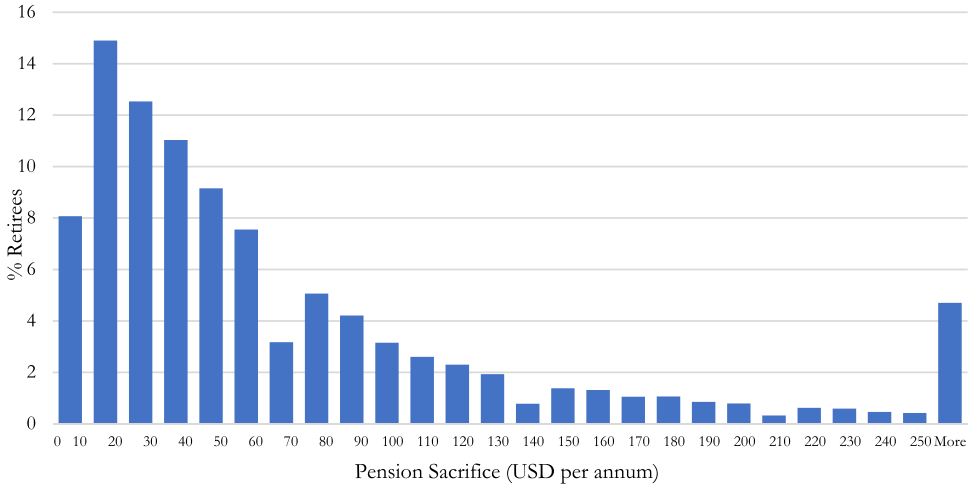

FIGURE 3 Distribution of pension sacrifice, by value in USD per annum. [Color figure can be viewed at wileyonlinelibrary.com]

As well as the distributional analysis above, Figure 4 illustrates the difference in coverage before and after the reform at each pension level and is overlayed with the number of retirees receiving each level of pension in our sample. This highlights the number of retirees for whom the difference in coverage is important. From Figure 4, we can see that, for example, over 9000 retirees would have received 6% less pension in case of default after the reform compared to the situation before the reform and over 7000 retirees would have received 5% less pension in case of default after the reform compared to the situation before the reform. These are both large

TABLE 7 Pension sacrifice by pension level.

Pension level	Mean	SD	Minimum	Maximum
In USD per annum				
Low pension level—T1	38.3	29.3	5.4	799.6
Medium pension level—T2	53.4	47.7	5.4	848.2
High pension—T3	130.7	144.5	5.4	2760.6
As a fraction of the individual's pension				
Low pension level—T1 (%)	1.22	0.94	0.14	22.95
Medium pension level—T2 (%)	1.04	0.90	0.08	18.30
High pension level—T3 (%)	1.15	1.09	0.02	22.48

Note: To define "low," "medium," and "high" pension levels, individuals are sorted into terciles by annuity value of the accepted offer (also denoted by T1, T2, and T3).

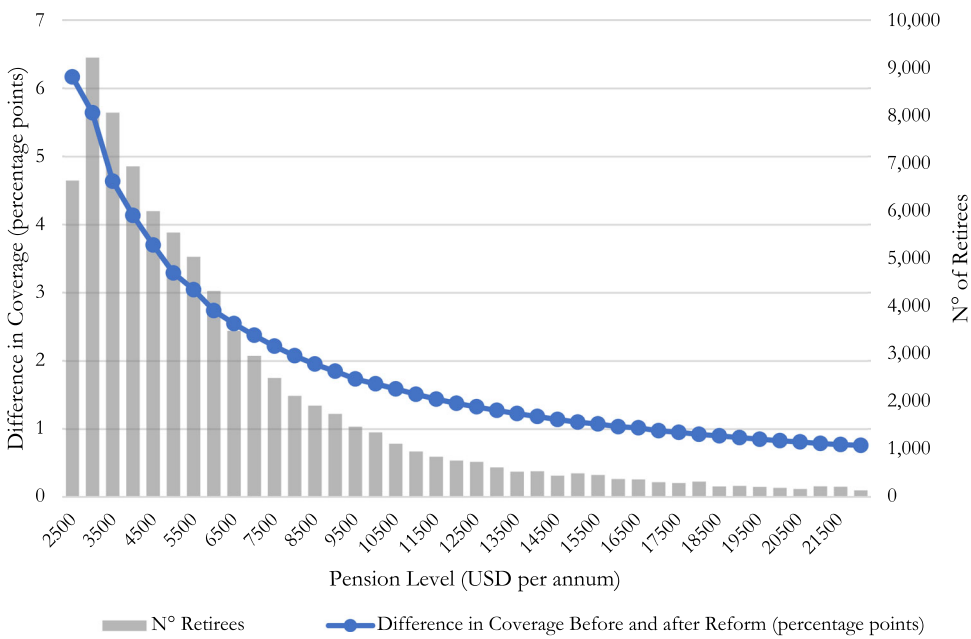

FIGURE 4 Difference in coverage before and after the reform by pension level. [Color figure can be viewed at wileyonlinelibrary.com]

amounts and large numbers of people and given the cumulative impacts of pension reductions, these sorts of numbers are material.

9 | CONCLUSIONS

We show that individuals, on average, are not able to correctly assess annuity provider default risk in the presence of government guarantees, as they do not include crucial information about their actual risk exposure in their annuity selections. Individuals are therefore incurring reduced annuity payments. Specifically, individuals declining the best pension value and opting for an annuity provider that exhibits a lower default risk are not sensitive to their actual coverage against the risk of default.

Additionally, when individuals' actual exposure to default risk increases, their willingness to pay for annuities from larger companies and for annuities recommended by a broker increases regardless of the risk rating of the provider. However, there is no evidence of changes in their willingness to pay for reducing the default risk of their provider. This pattern of behavior would indicate that although individuals perceive an increased risk, they are nevertheless unable to consider the direct source of risk in their decision-making, even when this information is publicly available and explicitly reported in the set of annuity offers received.

In looking at the quality of decisions by low- and high-income retirees, this poor decision-making is especially severe for low-income individuals. Low-income retirees are willing to sacrifice a higher proportion of their pensions to get a lower-risk provider, even when they are less exposed to that risk, because of the government guarantees that protect them from provider default.

Our results are consistent with the evidence that individuals struggle to consistently assess and value annuity products (Bateman et al., 2016; Brown et al., 2017; Chalmers & Reuter, 2012). In addition, our findings support the conclusion that individuals struggle to properly compare and assess multiple providers of standardized insurance products (Abaluck & Gruber, 2011; Bhargava et al., 2017; Keane & Thorp, 2016). Taken together, these results show just how cognitively challenging and complex retirement product selection in the real world can be. From the perspective of the individual, this is a high-stakes decision, as the irrevocable nature of annuity selection means that there are lifelong consequences resulting from not being able to fully incorporate all relevant information. At an aggregate level, people are poorer in retirement than they otherwise need be and our analysis shows that around 5000 people out of 28,000 people are forgoing over 2% of their annual annuity payment to select a safer provider, despite the low risk of insurer default, then these results have significant policy implications in both Chile and beyond.

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