The costs of annuitizing

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Abstract

This study analyzes the costs associated with annuitization and provides estimates of the margin that an efficient insurance company could charge in order to cover these costs. Using data from the financial statements filed by insurance companies to the regulator, we estimate a translog cost function following the stochastic frontier methodology. Our dataset consists on quarterly balance sheet information from 13 Uruguayan insurance companies over the period 2005-2015. We find that the average cost inefficiency is 17.8% and that there is substantial heterogeneity across firms. In addition, our results show that the annuity margin that an efficient insurance company could charge in order to cover its administrative costs is of 11 basis points over the market long-term interest rate.

*IEL: D24, G22, G28, H55
Keywords: annuities, insurance firms, annuity margin, stochastic frontier, cost efficiency

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1 Introduction

A typical retiree faces two main risks when entering into the retirement phase of her life: the risk of living more years than expected and, hence, running out of savings, and the risk of the negative effects of market volatility on the accumulated funds. An immediate annuity is a product commonly used to cope with these risks. When acquiring an immediate annuity, the retiree is promised to receive regular payments by an insurance company for the rest of her life in exchange for a one-time premium payment.

In particular, one of the sources of financial risk faced by retirees today is given by the uncertainty about how long they are going to live or, what is known as the longevity risk. Insurance companies that offer life annuities pool resources of annuitants, bearing the costs associated with providing this product; among them: administrative expenses, wages, commissions to agents, and adverse selection. The last source of costs is due to the fact that annuitants usually have longer life expectancies than the general population, which reduces the insurers’ ability to pool mortality risk. Nonetheless, this adverse selection cost can be significantly reduced under compulsory annuitization.

If the costs of providing annuities are significant, insurance companies may be tempted to charge more than what would be charged for an “actuarially fair” annuity. A concept usually applied to measure how far from an actuarially fair level is an annuity is the Money’s Worth Ratio (MWR), which can be defined as the ratio of the present value of all the discounted future payments a retiree will receive and its cost when she retires. Hence, an annuity with an MWR equal to one can be considered actuarially fair because the initial cost is equivalent to the present value of all the expected future payments.

Although the MWR is quite an intuitive concept, it can be difficult to make comparisons across countries or different individual characteristics, since the products offered by the insurance companies can be very different in terms of their duration. An alternative perspective could be based on the yield obtained from the annuity, which may be compared with the yield on alternative financial assets in order to arrive to an annuity margin, that is, the reduction in yield associated with investing in an annuity rather than in alternative investments.

We propose a different approach to study annuitization costs. The primary contribution of this paper is to assess the costs of providing annuities in order to evaluate the margin that an efficient firm could charge in order to cover these costs. For this we use data from the financial statements that insurance companies
must file each quarter to the regulatory and supervisory authority. The data covers financial statement information from 13 Uruguayan insurers during the period 2005-2015.

To our knowledge, this is the first study that estimates an annuity margin for Uruguay. Previous literature focused on the annuity margin, \( m \), defined as the difference between a market long term interest rate and the implicit annuity rate. We focus on insurance companies' costs and estimate an “efficient margin” that includes the insurance company administrative costs but excludes adverse selection costs. To do this, we rely on the stochastic frontier approach to estimate insurance companies translog cost function. According to the stochastic frontier model, output has an upper bound given by a stochastic production frontier. The stochastic nature of the frontier is explained by the notion that its location may vary randomly. Hence, the error term of the functional form is given by the combination of two terms: a symmetric normal term that captures randomness outside of the control of the firm, and a one-sided component capturing randomness that can be controlled by an efficient firm.

According to our estimations, an increase of 1,000 pesos in the individual funds accumulated during the working life, implies an increase of 10.21 pesos in costs. Given that an average annuity premium is 1 million pesos, the total administrative costs associated to an average annuity during the whole payment period is 10,210 pesos. This translates into an annuity margin of 11 basis points over the market interest rate.

The rest of this paper is organized as follows. The next section provides a literature review. Section 3 briefly describes the main features of the Uruguayan pension system. Section 4 depicts how we compute the annuity efficient margin as well the functional form of the translog cost function and the estimation procedure. Section 5 summarizes the variables and the dataset used in the empirical analysis. Section 6 presents the estimation results, and Section 7 concludes the study.

## 2 Literature review

### 2.1 Money worth ratio and costs

The cost of annuitizing could be approximated by looking at the annuities MWR. There is a vast literature on MWRs around the world. Brown et al. (2001), Murthi et al. (2000a), Murthi et al. (2000b), Poterba and Warshawsky (2000) and Finkelstein and Poterba (2002) compute MWRs for the United Kingdom. They find that MWRs depend on the year and the type of annuity but, in general, MWRs in the United Kingdom
Similar results are found by Mitchell et al. (1999) for the US. They estimate the MWR of individual annuities available in the US private market in 1995 and find that it varies between 0.8 and 0.85. They also find that the MWR has increased over time, from 0.75 in 1985 to 0.82 in 1995\(^1\), but with most of the increase happening in the late 1980s.

James and Vittas (2000) and James and Song (2001) provide estimates of the MWRs prevalent in Australia, Canada, Chile, Israel, Switzerland, Singapore, the United Kingdom and the US arriving to similar results: MWRs are usually below, but close to 1.

There are less studies on the value of annuities in developing countries. Notable exceptions are James et al. (2006) and Thorburn et al. (2007). Using individual level data on different types of indexed annuities, Thorburn et al. (2007) estimate MWRs in Chile between 1999 and 2005. On average, MWRs in Chile have been above 1 in the period 2002-2005. The disaggregated data allows the authors to look at variation in individual MWRs, finding that MWRs range between 1.15-1.25 to 0.75-0.85, depending on the year. The authors associate this variation in MWRs to price differentiation based on annuitants characteristics and inefficiencies such as the lack of market transparency and the excessive influence of brokers.

An alternative way to look at the cost of annuitizing is by comparing the annuity internal rate of return with a rate of return available in the market, such as long term government or corporate bonds. In general, if the annuity price is actuarially fair, its internal rate of return should be close to a market long term return. Murthi et al. (2000a) define the annuity margin as the reduction in yield due to investing in an annuity instead of a benchmark market instrument. They find that the annuity margin in the United Kingdom is between 150 basis points in 1990 and 50 basis points in 2000. They also find a decline in the annuity margins in the 1990s and relate that to either increasing competition between insurance companies or a reduction in costs. Similarly, James and Song (2001) find that the annuity margin expressed in basis points with respect to risk-free interest rates are 111 in Canada, 197 in the US, 113 in Australia, 114 in the UK and 97 in Switzerland\(^2\).

Some of the studies on MWRs and annuity margins in different countries have also focused on the cost of annuitizing. Murthi et al. (1999) analyze costs in the UK system of individual accounts in the accumulation and payout phases. They break down the costs into three components: accumulation ratio, alteration ratio

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\(^1\) These results are for men aged 65 using the treasury yield curve and population mortality tables.

\(^2\) These results are for male-cohort tables based on own mortality data and retirement at age 65.
and annuitization ratio. The first two are costs associated with the accumulation phase. The latter reflects the costs of buying an annuity at the time of retirement. This could be further divided in the administrative costs incurred by the insurance company to provide the annuity and the adverse selection costs due to the fact that those buying annuities are likely to have longer life expectancies than the general population. To estimate the cost of adverse selection, previous studies have looked at the difference between MWRs using population mortality and MWRs based on annuitants mortality tables. According to Murthi et al. (2000a), adverse selection costs account for between a half and two-thirds of total costs in the United Kingdom. Similarly, Mitchell et al. (1999) estimate that the cost of adverse selection explains about half the total cost of an individual annuity in the US whilst Poterba and Warshawsky (2000) find that the adverse selection cost is about 80% of total cost.

2.2 Stochastic frontier

When thinking in terms of the costs of annuitizing, a relevant question is what would be the costs associated with and efficient provision of annuities. One of the challenges when measuring productive efficiency of firms is to establish benchmarks, being the article of Farrell (1957) the one that introduced the concept of “best practice reference frontier”. This concept specifies the maximum quantities of output a firm can produce for a given level of inputs, or for any given level of outputs, the minimum quantities of inputs needed. Hence, modern frontier efficiency methodologies estimate efficient frontiers by comparing each firm in the industry to a reference set consisting of the rest of the firms.

The two primary methods for estimating efficient frontiers are the parametric and the non-parametric approach. The later is usually applied through linear programming, while the former approach is based on the estimation of a cost, revenue or profit function. The parametric approach is stochastic, since firms can be off the frontier because they are inefficient or because of random shocks that are not related to inefficiency.

According to the stochastic frontier model, output has an upper bound given by a stochastic production frontier. The stochastic nature of the frontier is explained by the notion that its location may vary randomly. Hence, the error term of the functional form is given by the combination of two terms: a symmetric normal term that captures randomness outside the control of the firm (symmetrically distributed around the “true” frontier), and a one-sided component capturing randomness that can be controlled for by an efficient firm (one-sided since it is assumed to have a distribution that is truncated below by the frontier). Explicit
assumptions about the distribution of the asymmetric error term allow the estimation of the stochastic frontier.

The economic literature on efficiency includes a wide range of studies that apply the stochastic frontier methodology focusing on the insurance industry. In particular, Yuengert (1993), Cummins and Zi (1997), Cummins and Weiss (1998), Segal (2002) and Greene and Segal (2004) estimate cost efficiency in the U.S. life insurance industry.

Yuengert (1993) estimates a cost frontier with data from U.S. life insurance companies and groups for 1989. The main results imply the existence of scale economies in life insurance only up to $15 billion in assets and an average inefficiency in the industry of between 35-50%.

Cummins and Zi (1997), on the other hand, compare cost efficiency estimates of 445 U.S. life insurance companies over the period 1988-1992. Applying a variety of econometric and mathematical programming methodologies, they find that the methodology choice has an important impact on the estimated cost efficiency values. In addition, Cummins and Weiss (1998) discuss the advantages and disadvantages of the main efficiency methodologies (the econometric approach and the mathematical programming approach), while also revising the most important decisions regarding functional forms applied, output and input definitions, and the results obtained by researchers.

Segal (2002) provides an analysis of life insurance companies expenses and estimates benchmark expense factors that can serve as a guide for pricing new insurance products. Using data on U.S. life insurance companies for the period 1995-98, he estimates a cost function were total general expenses are a function of input prices and physical outputs. For the same period, Greene and Segal (2004) study the relationship between cost inefficiency and profitability for a panel of 136 U.S. life insurance companies. They find that the industry is, on average, 20% inefficient and that cost inefficiency displays a negative relationship with profitability, while there is no significant relationship between inefficiency and the organizational structure of the firm.

On the other hand, examples of applied econometric methods to cost efficiency estimations for the insurance industry in other countries include Fecher et al. (1993), Fenn et al. (2008) and Eling and Luhnen (2010). Fecher et al. (1993) assess the productive efficiency of life and non-life French insurance companies using data on 84 life and 243 non-life companies for the period 1984-1989. They use both parametric and non-parametric approaches, finding a high correlation on the results obtained with each method. Fenn
et al. (2008) apply stochastic frontier analysis to measure cost inefficiency in the European insurance sector. They use data of insurance companies accounts for 14 major European countries from 1995 to 2001. They find strong evidence that the inefficiency of insurers dedicated to only one line of business (life or non-life) increases with firm size and domestic market share, while that of composite firms appears to be low and to vary little with size. Eling and Luhnen (2010) evaluate efficiency in the international insurance industry applying different methodologies to data of 6,462 insurance companies from 36 countries for the period 2002-06. They find that the international insurance industry displayed a steady growth in efficiency during that period. This results do not vary significantly when applying data envelopment analysis or stochastic frontier analysis.

Finally, there are some estimations of efficiency for the banking and the insurance industries in Uruguay. For example, Ponce and Tansini (2001) evaluate technical efficiency for 20 Uruguayan private commercial banks during the period 1992-1999 through a translogarithmic production function and under the assumption of a truncated normal distribution for the efficiency component of the error term. In addition, Sanín and Zimet (2003) study the efficiency of the Uruguayan insurance industry for the period 1995-2001. They apply both a parametric and a non-parametric approach for the estimation of the technical frontier, arriving to similar results. In particular, they find an increasing trend in the technical efficiency of the Uruguayan insurance industry after it was demonopolized.

3 Uruguayan pension system

The Uruguayan pension system is a hybrid system with two interconnected pillars. A first defined benefit (DB) pillar administered by the public social security agency (Banco de Previsión Social) that has an inter-generational solidarity component, and a second pillar that is regulated and supervised by the Uruguay Central Bank through the Superintendence of Financial Services (SFS) and is defined contribution (DC) in nature. There is mandatory annuitization at retirement for those contributing to the DC pillar and the pillars complement each other since workers can contribute to each of them at the same time.

As it is usual in DC pension systems, the pension funds transfer the individual fund to an insurance company that provides annuities. At the time of retirement, the pension fund transfers the individual accumulated funds to an insurance company, which is the the one in charge of calculating the annuity initial
payment with a set of technical parameters provided by the regulator. In particular, the SFS is in charge of
the provision of mortality tables - taking into account the probability of leaving beneficiaries - and of setting
the minimum regulatory interest rate for the computation of the annual payments. According to the 1989
Constitutional Reform, pension income is linked to the Average National Earnings Index (ANEI), so the
insurance companies have to provide earnings-linked annuities.

Nowadays annuities are provided by only one insurance company, which is owned by the public sector
and is also in charge of the disability pensions. During the initial stages of the system, pensions were also
provided by private firms, but due to problems with the structure of the system they were discouraged to
participate in the annuities market. A particular problem is the fact that there are no long-term earnings-
linked instruments to hedge assets and liabilities in ANEI. On top of that, they complain about the arbitrary
mechanism for the fixation of regulatory interest rate and the outdated mortality tables.

4 Estimation

4.1 Money worth ratio and annuity margin

Assume a person retires at time $t = 0$ and has a maximum length of life of $T$. The MWR is defined as the
expected present discounted value (EPDV) of the income stream from an annuity over its purchase price.
Let $p_t$ be the probability of surviving until time $t$, $A_t$ the payout at time $t$, and $i$ the annual interest rate.
Then, we can express the EPDV as:

$$EPDV = \sum_{t=0}^{T} \frac{p_t A_t}{(1 + i)^t}$$

Define $F$ as the purchase price or premium of the annuity; in the case of mandatory annuitization, it is
given by the amount that is transferred from the pension fund to the insurance company. The MWR can be
expressed as:

$$MWR = \frac{EPDV}{F}$$

An actuarially fair annuity would pay, on average, a dollar per each dollar premium and thus the MWR
would be equal to 1. Murthi et al. (2000a) suggest an alternative way of looking at the cost of annuities:
the annuity margin. The yield of the annuity, taking into account the annuitant expected mortality, can be compared to the rate of return of a benchmark asset in the market. Then, annuity costs are expressed in terms of the reduction in yields or differences in the rate of return of the annuity vis-a-vis what could be obtained in the market. Let’s define $m$ as the annuity margin that captures the insurance company administrative and adverse selection costs. The EPDV can be expressed as:

$$EPDV = \sum_{t=0}^{T} \frac{p_t A_t}{(1+i-m)^t}$$

Murthi et al. (2000a) compare the implicit annuity rate of products sold in the United Kingdom with the prevalent market rate to estimate $m$. We are interested in obtaining the “efficient annuity margin”. For that, we obtain the efficient cost of providing annuities by estimating the insurance companies cost function. With the estimated cost per amount of premium we are able to obtain an estimate of the efficient annuity margin.

Without considering the insurance company costs, the annuity payment should be equal to the expected discounted purchase price:

$$A = \frac{F}{\sum_{t=0}^{T} \frac{p_t}{(1+i)^t}}$$

If we take into account the costs that the insurance company incurs when providing annuities, on average, the annuity payment, $A^*$, plus the annuity annual costs, $AC$, should be equal to the expected discounted purchase price:

$$A^* + AC = \frac{F}{\sum_{t=0}^{T} \frac{p_t}{(1+i)^t}}$$

Let $C$ be the total cost of providing the annuity, i.e. the costs incurred by the insurance company over the expected length of the annuity payment. The expected annual costs, can be expressed as:

$$AC = \frac{C}{\sum_{t=0}^{T} \frac{p_t}{(1+i)^t}}$$
Then:

\[
A^* = \frac{F - C}{\sum_{t=0}^{T} \frac{p_t}{(1+i)^t}}
\]

Alternatively, we can express \(A^*\) as a function of the efficient annuity margin \(m^*\):

\[
A^* = \frac{F}{\sum_{t=0}^{T} \frac{p_t}{(1+i-m^*)^t}}.
\]

This expression allows us to estimate the efficient annuity margin or the reduction in yields after taking into account the insurance company costs of providing annuities. Note that \(C\) is the total cost that the insurance company incurs when offering annuities and includes overhead related costs, taxes, contingency reserves, marketing costs, among others. It is important to emphasize that, in this study, the cost of adverse selection is not included in \(C\). This is less a concern under mandatory annuitization but could be important in voluntary annuity markets.

### 4.2 Stochastic Frontier

As was already mentioned, for the sake of obtaining the “efficient annuity margin”, we need to compute the efficient cost of providing annuities. For that we estimate insurance companies’ cost function based on the stochastic frontier approach. In particular, we use a translog cost function with the following general specification:

\[
\ln C_{it} = \alpha_i + \sum_j \delta_j \ln Y_{j,it} + \frac{1}{2} \sum_j \sum_k \delta_{jk} \ln Y_{j,it} \ln Y_{k,it} + \sum_z \eta_z \ln W_{z,it} + \frac{1}{2} \sum_z \sum_s \eta_z \ln W_{z,it} \ln W_{s,it} + \frac{1}{2} \sum_j \sum_z \rho_{jz} \ln Y_{j,it} \ln W_{z,it} + \sum_q \beta_q Q_{it} + \sum_y \gamma_y D_{it} + u_{it} + v_{it}
\]

where \(C_{it}\) represents the total cost of firm \(i\) at time \(t\), \(Y_{j,it}\) represents the output of each insurance category \(j\) (life and annuities, car and fire insurance) for firm \(i\) at time \(t\), \(W_{z,it}\) represents the prices of the inputs \(z\) (labor, financial capital, physical capital and materials) of firm \(i\) at time \(t\), \(Q_{it}\) and \(D_{it}\) are dummy
variables capturing quarter and year effects respectively, $u_{it}$ is the one-sided inefficiency term, and $v_{it}$ is the idiosyncratic error.

Total cost is defined as total operating cost, which includes the sum of labor, physical capital and materials expenses. This definition also includes the risk that the insurance firm decided to re-insure with another insurance company but excludes insurance claims of customers since they are a liability for the insurance company.

As we have already mentioned, the stochastic frontier model is based on the idea that deviations from the benchmark frontier represent the individual inefficiencies. From the statistical point of view, this is implemented through a composite error term in which the classical idiosyncratic disturbance is included together with a one-sided disturbance term that represents inefficiency. For the one-sided inefficiency disturbance, several distributions have been suggested, such as the positive truncation of a normal distribution with zero-mean (half-normal), the positive truncation of a normal distribution with nonzero mean (truncated normal), the exponential distribution, and the gamma distribution.

Our model includes unit-specific intercepts, allowing to disentangle time-varying inefficiency from unit specific time invariant unobserved heterogeneity. Specifically, our estimations are based on a “true fixed effects” model (Greene (2005)) assuming a half-normal distribution for the inefficiency component of the error term.

After completing the estimation of the cost function, we attempt to determine the margin that an efficient insurance company providing annuities could charge customers in order to cover the costs incurred. For that, we take the median values of the premium outputs and input prices and compute the marginal cost associated with the life and annuities output for a median firm:

$$\frac{\partial \ln C}{\partial \ln Y_{VP}} = \delta_{VP} + \delta_{VP,VP} \ln Y_{VP} + \delta_{VP,Ve} \ln Y_{Ve} + \delta_{VP,I} \ln Y_{In} + \rho_{VP,K} \ln W_{K} + \rho_{VP,F} \ln W_{F}$$

where $C$ are the total costs divided by the labor price, $Y_{VP}$, $Y_{Ve}$ and $Y_{In}$ represent the outputs associated to life and annuities, car and fire insurance categories respectively, and $W_{K}$ and $W_{F}$ are the relative prices of the physical and financial capital inputs in terms of the labor price$^3$.

$^3$Before estimating the cost function, we impose the homogeneity constraint by dividing all input prices and total costs by the price of labor.
If we focus on the effect of an increase in the quantity of life and annuities premiums over the total cost of the firms:

\[
\frac{\partial \ln C}{\partial \ln Y_{VP}} = \frac{\partial C}{\partial Y_{VP}} \frac{Y_{VP}}{C}
\]

So the marginal cost with respect to the life and annuities insurance category is given by:

\[
MC_{VP} = \frac{\partial C^*}{\partial Y_{VP}} = \frac{\partial \ln C^*}{\partial \ln Y_{VP}} \frac{C^*}{Y_{VP}}
\]

(4.3)

where \(C^*\) is the efficient cost.

5 Variables definition and data

5.1 Definition of outputs and inputs

A key element in efficiency analysis is the definition of outputs and inputs and their prices. This is particularly challenging in the service sector, since outputs might be intangible and prices may be implicit. In the case of life insurance, the outputs are mainly the services provided by the firm. In general, life insurers provide a risk-bearing/risk-pooling service (they collect premiums and redistribute most of the funds to those policyholders who sustain losses) and an intermediation service (funds are collected in advance of paying benefits and are held in reserves).

We define outputs as the gross premiums collected\(^4\), including also the risk that the insurance company has re-insured with another firm, in order to avoid dealing with negative outputs. Given that insurance premiums represent revenues, i.e. price time quantities, rather than physical output, we deflate them by the CPI index. Finally, given that we apply a log transformation to the data and we have zero values because not all firms offer every insurance service available in the market, as it is standard in the literature\(^5\), we add 0.01 to the output variable to allow logs to be taken.

The inputs included in the analysis are classified into three main categories: labor, financial capital, and physical capital and materials. Labor could also be separated into agent labor and the rest, mainly

\(^4\)Reserves are also commonly used as a proxy for life insurance outputs, but since they are a stock, they only capture the amount of business an insurer must carry from each year. Premiums, on the other hand, capture the flow of services.

\(^5\)See for example Cummins and Zi (1998).
because they are paid in different ways. In this particular study, agent costs are excluded from the analysis because the annuities line of business, which plays a significant role in the Uruguayan insurance market and is expected to have an increasing importance in the market, is not allowed to charge commissions. The price of labor is defined as the ratio of total labor expenses to the total number of employees.

Financial capital is included as an input for the risk-pooling/risk-bearing function since insurers must hold capital in order to back their commitment to pay benefits. The price of financial capital is defined as the three years moving average of the return on equity (ROE) of the insurance industry. Initially, the variable was defined in terms of each firm, but negative results would imply a negative price for this input and a large number of observations would have been excluded from the estimation.

Physical capital and materials expenses include rent, equipment rental, and depreciation. We do not have information to compute the price of each of these components, so we define the price of this input as the ratio of expenses associated to physical capital and materials divided by the value of these assets.

### 5.2 Data

We construct a dataset based on information from the regulatory quarterly statements filed by insurers to the SFS from December 2005 to December 2015. This period includes a few mergers and acquisitions between companies, so we treated these cases as if they had happened at the beginning of the sample period.

The initial sample consists of 467 firm-quarter observations. We focus on the insurance products that represent the largest portion of the total market: life and annuities, car and fire insurance. We exclude from the sample the reinsurance and the accident lines of business. The decision to exclude the reinsurance line of business is because it includes a wide range of insurance products, while the accidents insurance is excluded because in Uruguay this type of insurance is only provided by the public insurance company. Moreover, we also exclude firms for which the data displays negative direct premiums or positive expenses. As a result, the final sample consists of 13 firms and 420 observations.

In addition, in order to compute MWRs, we need information on the term structure of interest rates, the survival probabilities at different ages and the annuity premiums. As already discussed, pension income in Uruguay is linked to earnings growth rates and thus both the interest rate and the annuity payments

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6 An adequate approach to measure the cost of equity capital would be to use the market value of ROE, but since there are no insurers publicly traded in Uruguay, this is not possible. As a result, book value measures are used.
are going to be expressed in earnings growth terms. An important drawback of working with Uruguayan data and a major issue for the development of a competitive annuity market is the lack of a well developed financial market in instruments linked to earnings. Given the lack of earnings-linked financial instruments, we use the term structure of inflation-linked securities. In order to arbitrate the rates of return expressed in CPI growth to rates expressed in terms of earnings growth we assume that the long-term growth of the real wage is 2.4%. This is the result of estimations for the growth of potential product and population of 2.9% and 0.5% respectively.

Finally, since the computation of an annuity involves discounting the future payments that the retiree would receive, it is important to consider the probability that she survives each year. The SFS provides the mortality tables that the insurance companies that participate in the pension market must use in order to calculate the annuities initial payment. Until 2016, these mortality tables were based on static mortality rates by age and sex. Since they did not include a dynamic dimension, they were inadequate to adjust the present value of the future payouts. In addition, the static factor determine that the tables would soon be outdated. Given this, the regulator is considering the introduction of new mortality tables with a dynamic dimension, which are based on the mortality rates of the stock of retirees for the period 2011-2013 and on projections of these rates for the period 2011-2100. These are the mortality tables used in this study.

6 Results

In this section we discuss the results of our estimations in terms of MWRs, cost inefficiency per firm and the efficient annuity margin.

6.1 MWR

Figure 6.1 shows the long term interest rate expressed in terms of earnings growth between 2003 and 2015 together with the regulatory rate used for the computation of annuities in Uruguay. Until June 2012 the regulatory rate was set equal to 3% and reduced to 1.5% from July 2012 until now.
The fact that the regulatory rate is fixed for relatively long periods results in large variations in the MWR over time. Figure 6.2 shows the MWR between 2003 and 2015 using a regulatory rate of 3% until June 2012 and of 1.5% from July 2012 onwards. The value-per-premium peso ranges from 0.65 in July 2004 to 1.32 in March 2011.

Figure 6.2: Money Worth Ratio in Uruguay

How does this compares with MWR in countries with competition in the annuity market? Two well known annuity markets are Chile and the United Kingdom. Figure 6.3 shows the MWR in Uruguay, Chile
and the United Kingdom between early 2010 and the end of 2015. In line with previous literature, our results suggest that pensioners in the United Kingdom receive less than one per each GBP premium. A similar pattern emerges from analyzing MWRs in Chile. Annuities in Chile received about 95 cents per Chilean peso in annuity premiums from 2010 until the beginning of 2015; since then, the MWR has been consistently above 1. This finding is not new because Thorburn et al. (2007) also find MWRs above 1 in the period between 2002 and 2005. We are using long-term government bonds as the interest rate benchmark, but it could be the case that insurance companies in Chile are obtaining higher yields on their investments and thus offering annuities with higher implicit returns.

Figure 6.3: Money Worth Ratio in Uruguay, Chile and the United Kingdom

6.2 Cost inefficiency and economies of scale

Table 6.1 shows the estimated coefficients of the cost function (Equation 4.2) that allows us to compute the stochastic frontier and the cost inefficiency incurred by each insurance company.

Figure 6.4 shows estimated average cost inefficiency in the Uruguayan insurance sector during the period 2006-2015. According to our estimates, production costs could be reduced 17.8%, on average. This result is in line with estimates for the US by, for example, Greene and Segal (2004) and for European countries by Fenn et al. (2008) who find that cost inefficiency was relatively stable between 1995 and 2001 and close to 20% for life specialist companies.

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7See, for instance, Murthi et al. (2000a) for historical data or Aquilina et al. (2014) for more up-to-date results.
Table 6.1: *Regression results: stochastic frontier*

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<tbody>
<tr>
<td>lnY$_{Ve}$</td>
<td>-0.462***</td>
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<tr>
<td>(lnY$<em>{Ve}$)(lnY$</em>{Va}$)</td>
<td>0.0393***</td>
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<tr>
<td>(lnY$<em>{Ve}$)(lnY$</em>{Va}$)</td>
<td>0.0477***</td>
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<td>(lnY$<em>{Ve}$)(lnW$</em>{K}$)</td>
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</tr>
<tr>
<td>(lnY$<em>{Ve}$)(lnW$</em>{F}$)</td>
<td>0.0118</td>
</tr>
<tr>
<td>lnY$_{Va}$</td>
<td>0.606***</td>
</tr>
<tr>
<td>(lnY$<em>{Va}$)(lnY$</em>{Va}$)</td>
<td>-0.0306***</td>
</tr>
<tr>
<td>(lnY$<em>{Va}$)(lnY$</em>{VP}$)</td>
<td>-0.0507***</td>
</tr>
<tr>
<td>(lnY$<em>{Va}$)(lnW$</em>{K}$)</td>
<td>0.0555</td>
</tr>
<tr>
<td>(lnY$<em>{Va}$)(lnW$</em>{F}$)</td>
<td>-0.00836</td>
</tr>
<tr>
<td>lnY$_{VP}$</td>
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</tr>
<tr>
<td>(lnY$<em>{VP}$)(lnY$</em>{VP}$)</td>
<td>0.0173***</td>
</tr>
<tr>
<td>(lnY$<em>{VP}$)(lnW$</em>{K}$)</td>
<td>-0.0608**</td>
</tr>
<tr>
<td>(lnY$<em>{VP}$)(lnW$</em>{F}$)</td>
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<tr>
<td>lnW$_{K}$</td>
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<tr>
<td>(lnW$<em>{K}$)(lnW$</em>{K}$)</td>
<td>-1.037***</td>
</tr>
<tr>
<td>(lnW$<em>{K}$)(lnW$</em>{F}$)</td>
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<tr>
<td>lnW$_{F}$</td>
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<tr>
<td>(lnW$<em>{F}$)(lnW$</em>{F}$)</td>
<td>0.0230</td>
</tr>
<tr>
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<tr>
<td>Quarter dummies ($Q$)</td>
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</tr>
<tr>
<td>$\sigma_u$</td>
<td>2309***</td>
</tr>
<tr>
<td>$\sigma_v$</td>
<td>0.0653***</td>
</tr>
<tr>
<td>$\lambda = \frac{\sigma_v}{\sigma_u}$</td>
<td>3.5438***</td>
</tr>
<tr>
<td>Observations</td>
<td>420</td>
</tr>
</tbody>
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* t statistics in parentheses
* * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
We also find that there is substantial heterogeneity in cost inefficiency across firms. Figure 6.5 shows cost inefficiency over time for each of the 13 firms included in our sample. Even though we find that mean inefficiency is relatively stable over time, there are differences in the evolution of cost inefficiency at the firm level. Whilst there are firms for which we observe a stable cost inefficiency over the sample years, there are other firms - like number 4 and 11 - for which inefficiency has increased over the last years of the sample. Finally, there is a group of firms, such as firm 5 and 15, for which we find important declines in inefficiency over time. Take the example of firm 5, the reduction in cost inefficiency is from 40% in 2006 to 20% in 2015.
Figure 6.5: Cost inefficiency by firm

According to our estimates, cost inefficiency ranges between 1.6% to 87.6%, whilst median inefficiency during the period under analysis is 13.2%. This suggests that, at least for some months, there are insurance firms in Uruguay producing close to the efficient cost frontier.
With the estimated cost function we can not only estimate cost inefficiency but also economies of scale. In a multi-product firm, economies of scale ($\phi$) can be estimated from the following equation:

$$\phi = \frac{1}{\sum_j \frac{\partial \ln C_j}{\partial \ln Y_j}}$$  \hspace{1cm} (6.1)

Then, we can state that the insurance sector exhibits increasing returns to scale if $\phi > 1$, constant returns to scale if $\phi = 1$ and decreasing returns to scale if $\phi < 1$. Economies of scale allows us to infer whether insurance companies suffer cost savings or dis-savings as its output increases. We estimate equation 6.1 at the mean, median, 25th and 75th percentiles of outputs obtaining economies of scale equal to 1.18, 1.23, 1.29 and 1.22 respectively. Then, according to our results the insurance industry in Uruguay exhibits increasing returns to scale.

### 6.3 Annuity margin

With the estimated cost function and equation 4.3 we are able to recover the marginal cost defined as the present value marginal expenses of life insurance and annuity policies. The estimated marginal cost is 0.011755, whilst the estimated marginal efficient cost is 0.010206. Then, an increase of 1,000 pesos in the individual funds - or annuity premium - implies an increase of 10.21 pesos in costs. If we think that the average annuity premium is currently 1 million pesos, the total administrative costs of the average annuity
during the whole payment period is 10,210 pesos. From equation 4.1, this is equivalent to an efficient annuity margin of 11 basis points over the market interest rate. If we also consider a 1% profit margin over premiums, the efficient annuity margin increases to 22 basis points. This is less than the reduction in yields estimated by Murthi et al. (2000a) between 1989 and 1999 and Aquilina et al. (2014) between 2006 and 2014 in the United Kingdom. It is expected that we find a lower annuity margin at least for two reasons. First, we are looking at the efficient annuity margin whilst the previous literature focused on the annuity margin charged by insurance companies that might be operating out of the efficient cost frontier. The second explanation is because we are not considering the adverse selection cost in the estimation of the efficient annuity margin but only administrative costs. This is a concern in voluntary annuity markets but might not be that important under compulsory annuitization.

Our estimates are not sensitive to the market interest rate and are slightly affected by the insurance company profit margin. Figure 6.7 shows the sensitivity of the annuity margin to the profit margin. For instance, whilst the annuity margin is 27 basis points for a profit margin of 1.5%, it increases to 43 for a profit margin of 3%. To obtain a reduction in yields of 100 basis points, similar to that obtained by previous literature for the UK, the insurance company profit rate over premiums should be about 8%, which ought to be enough to cover administrative and adverse selection costs.

Figure 6.7: Sensitivity of the annuity margin to profit margin
7 Conclusion

In this paper we propose a new approach to study annuitization costs. Previous literature focused either on the MWR or the annuity margin. We use data from the financial statements that insurance companies must fill each quarter to the regulatory and supervisory authority in Uruguay in order to estimate the efficient cost of providing annuities and calculate the efficient annuity margin.

Then, we estimate a translog cost function allowing for time varying inefficiency and individual heterogeneity and find that the average cost inefficiency in the Uruguayan insurance sector during the period 2006-2015 has been stable and close to 18%. This implies that insurance companies could attain the same level of output with a reduction of 18% in their costs. In addition, we show that there is substantial heterogeneity in cost inefficiency across firms, with some firms working close to the production frontier and other firms showing cost inefficiency of almost 90%.

With the estimated cost function we are able to recover the marginal cost of providing annuities. We find that the efficient marginal cost is 0.010206, implying that an increase of 1,000 pesos in the annuity premium results in an increase of 10.21 pesos in costs during the whole payout phase. Without considering profits, this is consistent with an efficient annuity margin of 11 basis points over the market interest rate. It is worth emphasizing that this only includes administrative costs and, thus, does not take into account adverse selection costs, which have been found to be important in competitive annuity markets.

Note that our approach allows us to disentangle the different components of the annuitizing costs. Then, an interesting avenue for future research is the use of data on annuity policies in competitive markets in order to identify the costs associated with the efficient provision of annuities, the inefficiency costs and the adverse selection costs. Given the growing number of countries adopting pension systems based on individual accounts, a better understanding of the different components of the annuitizing costs is mandatory for the adoption of evidence-based policies.
References


Sanin, M. E. and F. Zimet (2003). Estimación de una frontera de eficiencia técnica en el mercado de seguros uruguayo. *Facultad de Ciencias Económicas y de Administración, Universidad de la República de Uruguay*.


Appendix

Annuity margin and MWR in Chile and the United Kingdom

Figure 7.1: Chile: annuity margin and MWR

Figure 7.2: United Kingdom: annuity margin and MWR
Sensitivity of the annuity margin

Figure 7.3: Sensitivity of the annuity margin to costs

Figure 7.4: Sensitivity of the annuity margin to market long-term interest rate