Pensions Fund Projection

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Abstract

The pension system in Chile is based on an individual capitalization system that, by construction, generates a significant accumulation of funds. At December 2016, pension funds reached US$ 174,480 million, representing 70.8% of the GDP. Due to its relative importance in the economy, the Superintendence of Pensions has developed a projection model of pension funds for the period 2017-2039. The model design is based on sociodemographic cells created upon administrative data, using key idiosyncratic and social security variables. Based on this structure, the model allows to project workers' characteristics and their resulting pension funds in the future. In turn, it allows to estimate the impact of sociodemographic changes and/or future reforms in the system.

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Introduction

Forecasting the evolution of pension funds is crucial for public policy decisions, especially in Chile. At December 2016, pension funds reached US $ 174,480 million, which represent 70.8% of the GDP. In turn, 61% of these are invested in the domestic market, so projecting the trajectory of pension funds is not only an important input for any reform that is evaluated in the pension system, but for the economy as a whole.

Reforms to the pension system not only impact the economy at the microeconomic level but have various effects at the macroeconomic level as well, such as in the capital market, the labor market and national savings, among others. Having a model that allows observing the value of pension funds in the long term would allow making better decisions associated with the different factors that determine their accumulation.

The accumulation of funds is determined by an income/expenditure scheme. On the one hand, the income of the system allows accumulating funds through the contributions of workers in the formal market during their active life, which depends on the number of monthly contributors, wages, investment returns and the contribution rate. On the other hand, the expenses of the system are all those payments that are made in the retirement phase of the individuals.

Likewise, there are exogenous variables to the pension system that affect accumulation. These are related to demographic changes that affect both income and expenses, either through variations in the number of individuals of working age, on the one hand, as well as an aging population, on the other.

Finally, the variables that relate to labor market and to economy's growth are usually increases in labor market formality and the level of wages, respectively. Likewise, other relevant variables are reductions of the wage gap between men and women, increases in the participation of the latter and greater profitability of the funds invested in the domestic market.

The projections show that pension funds will increase by 183% at the end of the projection period (2039). This translates into an increase of 41 p.p. as a percentage of the GDP, from 69% to 110%. Also, members would increase by 26% and contributors would reach a maximum of 7 million individuals, which corresponds to 55% of total members, a proportion that is assumed constant through the projection period (2017-2039).

The document is divided into three parts. The first deals with the proposed methodology for valuing pension funds in a long-term horizon, through a description of the data used and descriptive statistics. In the second, a projection model based on sociodemographic indices grouped by sex, age and type of fund is developed. Additionally, the results of the projection are presented and variations on the main parameters are carried out in order to present different possible accumulation scenarios. The third section concludes and poses future challenges.

Background

The Chilean pension system is based on individual capitalization following a defined contribution structure, in which each member has an individual account where pension contributions and the return obtained from the investment of these funds are accumulated through the accumulation phase or the labor market cycle (Superintendence of Pensions, 2010).

In its origin, the law established that each Pension Fund Administrator (AFP is the acronyms in Spanish) could administer a Pension Fund. This was maintained until 1999, when, through Law No. 19,641, a second fund was created (Fund Two), with the objective of "protecting retirees and individuals close to retirement from fluctuations in the investment returns of the Pensions Fund". In Fund two it was necessary to invest in fixed-income securities with a limited term, expecting that the profitability would be less fluctuating than in Fund one (BCN, 2017).

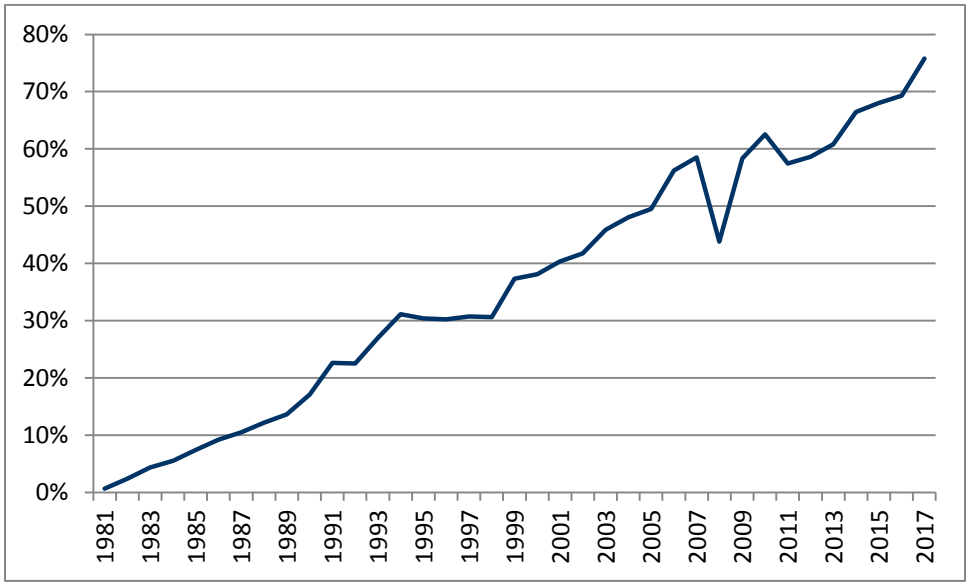
Subsequently, in 2002, through Law No. 19.795, the number of existing funds was increased to five, differentiated in the proportion of their portfolio invested in equity instruments. The objective of this change was to increase the expected value of the pensions that members would receive at the time of retirement, by investing in a portfolio whose risk is associated with the investment horizon, which would increase the expected value of the pension (Superintendency of Pensions, 2010).

Regarding the instruments in which the Pension Funds can be invested, at the beginning only the investment in some national fixed-income securities was allowed. However, in the 80s investment in national shares was introduced and in the 90s and 00s investment in foreign instruments was also included. All these modifications also included new investment limits (Superintendence of Pensions, 2010). The last modification regarding the investment portfolio of the Pension Funds occurred in 2017, when alternative assets were included.

Currently, DL No. 3,500 establishes general guidelines for the eligibility of instruments, structural limits and limits regarding issuers. The regulation of specific matters, which require greater flexibility, it is set in the so called Investment Regime, which is issued by the Superintendence with evaluation of the Investment Technical Council (Superintendence of Pensions, 2010).

Since the creation of the system, pension funds have experienced a sustained increase reaching over 70% of the GDP in 2016.

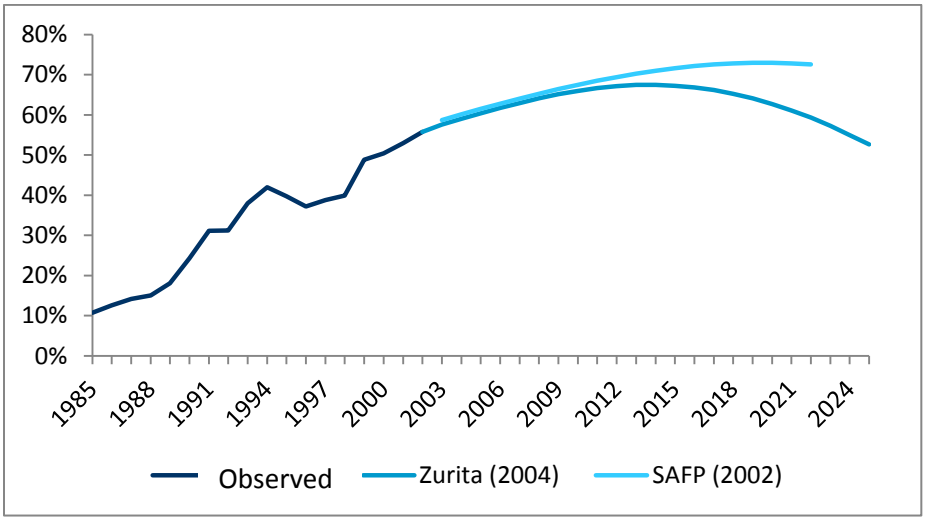
Figure 1. Historical evolution of Pension Funds as % of the GDP.



Source: Superintendence of Pensions.

To our knowledge, there are only two research papers projecting pension funds for the Chilean market. Zurita (2004) develops a projection of the pension funds between 2003 and 2025. His work is based on the observation of the significant increase of the pension funds during the first two decades since creation of the system. His main objective was to analyze their effects on the financial market of this increase. This is an accounting model, with behavioral equations estimated independently of each other, composed by exogenous and endogenous variables. This model projected an increase in funds, which would have reached a maximum in 2014, representing 67% of the GDP, decreasing in subsequent years until reaching 53% in the last forecasted year (2025). This was compared with the projection made then by the Superintendence, which projected a maximum of 73% in 2020 (Chart 2).

Figure 2. Projections of Zurita (2004) and Superintendence of AFP (2002) Pension Funds.



Source: Zurita, 2004.

The projections of different results of the pension system are crucial for public policy, given that they help in evaluating the effects of reforms or changes in the labor market, population or any relevant aspect of the system that is expected to have an impact in the long term (OECD, 2015). The methodology will depend on both the characteristics of the system and the information available and the objectives of the projection.

In a joint effort by the European Commission and different European Union countries, different schemes and models of pension projection were analyzed in order to evaluate both the impact of reforms and changes in the population on fiscal spending. Most of the models presented were based on a **semi-aggregate simulation approach**. This deterministic model simulates the functioning of the pension system given certain demographic, labor and macroeconomic conditions that determine the probabilities of changes between different states (employees, pensioners, death) year by year (EPC, 2007). In this type of model, variables such as the amount of the pension or the wages are considered as the average of the different groups of aggregation, for pensioners and active members, respectively.

There are different variations on the strategy described. For example, some countries must incorporate multiple structures or pension schemes in the same model, through **partial equilibrium models**.

On the other hand, the need to project distributions, allowing heterogeneous behavior among the different agents, would be achieved through limiting the aggregation unit to individuals, from a representative sample of the population, through **dynamic microsimulation models**, in which the state of an individual is updated from a sequence of sub-models (DIPRES, 2016). This is the approach used in the pension module of the last evaluation report on the sustainability of the Pension Reserve Fund in Chile, to project pensions and expenses associated with current pensioners (DIPRES, 2016).

The model designed and described here corresponds to a deterministic model in which individuals are group together according to sociodemographic variables relevant to the accumulation of funds (age, sex and type of fund). The probability of these groups moving from one state to another is given by the behavior observed in the current data. In this way, a simple, efficient and flexible model is proposed and tested.

Data

The data used in the model were obtained from the administrative datasets of the Superintendence of Pensions, specifically from the Database of Members, Contributors, Beneficiaries, Pensioners and Deceased (BDA). The tables used by the BDA correspond to people, accounts, movements of individual accounts and members retired.

Members and balances

In order to identify the members and their respective balances, we consider data from March 2016. All members that maintain a personal account in the AFP at this specific date are the sample to be considered.

Only active and inactive members with compulsory individual contribution accounts (CCICO) are kept. In addition, duplicates are eliminated, considering the highest age recorded and only those between 18 and 110 years remain.

The resulting dataset, members by age and sex, is crossed with the data of accounts, where the information of balances of the CCICO is obtained. If there are balances of these accounts in different funds, the balances of all the funds are added together and the type of fund that exhibits the lowest risk is considered.

Finally, data that do not comply with the regulation on restrictions regarding age and the type of investment fund is changed accordingly. On the one hand, men and women over 50 years and 55 years, respectively, who record balance in fund A. On the other hand, men and women over 65 and 60 years old, respectively, who registered balance in fund B. These are reassigned to the other funds in proportion to the distribution of the remaining funds.

The final dataset contain information on the number of members and total accumulated balance of these members, by age, sex and type of fund.

Contributors

The proportion of members that are listed in the CCICO, or contributors, is calculated as all those people who register a quote in the dataset of movements, in March 2016. For this purpose, only active or retired active (meaning pensioners that are still working and contributing) members are considered, between 18 and 110 years, every time a credit is registered in her/his account, either as a dependent or independent worker.

For members with more than one contribution during the period, the taxable salaries in that period are added together. Also, women and men over 50 and 55 years old, respectively, who are listed in fund A, are reassigned to the rest of the funds, as well as those over 60 and 65, who are in fund B.

The final base has information on the number of contributors and their average taxable remuneration by age, sex and type of fund.

Pensioners

In the model, the main source of expenditure of pension funds corresponds to payments in the retirement phase of the members. These expenditures generate different types of flows according to the type of pension: programmed retirement (RP) or life annuity (RV). In the first case there is an annual outflow of funds until the balance ends, while in the second the outflow is fixed over time starting at the pension age, which is assumed to be the minimum legal retirement age.

Thus, for the projections of the pensioners' balances, the proportions of pensioners by RV and RP observed in the data of affiliated pensioners by old age in 2017 are considered by sex and type of fund. Additionally, for RPs, an equivalent life annuity is calculated with a rate that ranges between 3.30% and 3.43%, according to the projection scenario, and it is assumed that all members are married with male spouses 2 years older for women and female spouses 2 years younger for men.

Additionally, for the projection of the balances of the pensioners, it is necessary to assume a distribution of balances through the different types of funds when the active members meet the pension age. These proportions are calculated according to what was observed for pensioners in 2017, only to those retired by programmed retirement (RP).

Probability of dying

Finally, for the projection of retired members, the probability of dying or surviving is calculated, for men and women, at different ages and the different years of projection, according to RV2014 mortality tables, considering factors of improvement.

Descriptive Statistics

The following tables show the distribution of members, contributors and accumulated balances in March 2016, by type of fund and sex, according to the members and contributors datasets described in the previous section.

Table 1. Distribution of members and accumulated balance, by sex and type of fund. March 2016.

Sex	Type of Fund	Members		CCICO Balance	
		Amount	%	Million pesos	%
Women	A	491,014	4%	3,643,723	4%
	B	1,753,625	15%	5,665,273	6%
	C	1,504,398	13%	10,413,013	10%
	D	1,227,393	11%	7,277,888	7%
	E	316,176	3%	5,618,262	5%
Men	A	671,502	6%	8,862,468	9%
	B	1,857,686	16%	9,995,619	10%
	C	1,915,768	17%	25,643,860	25%
	D	1,149,431	10%	13,015,704	13%
	E	442,673	4%	12,779,943	12%
Total		11,329,665		102,915,751	

Source: Based on BDA data. Superintendence of Pensions.

It is observed that men represent a greater proportion both of members (53%) and of accumulated balances (68%). While in fund B and C number of members are the largest (31% and 30%), and the balances are concentrated in fund C (35%).

The total of the pension funds in Table 1 differs from the value mentioned at the beginning of the document, which corresponds to the assets of the pension funds at March 2016 for a total of $110,255,345 million. The difference of 7.1%, is mainly explained by the inclusion of only the CCICO, since the balance of the other accounts corresponds to 3.9% of the total. On the other hand, 1.5% is due to the filter associated with registering a valid CCICO account and being a non-deceased member (pensioner or not). The remaining 1.3% is explained because the value reported corresponds to the liabilities of the pension funds, which incorporate, in addition to the balances in the accounts, other equity accounts and liabilities, such as: lace, lagged contributions, collection in process of accreditation and transfers.

Table 2 shows the distribution of balances according to the different differences described.

Table 2. Distribution of pension funds according to sex and filters of the sample. In millions of pesos. March 2016.

Sex	Other Account Balances	CCICO Balance			Total accounts base	Total liabilities
		Non Valid	Valid			
			Age <18 or >110	Age 18-110		
Men	3,304,731	1,379,971	1,683	70,297,593	74,983,979	
Women	1,020,143	244,160	660	32,618,158	33,883,121	
Total	4,324,874	1,624,131	2,342	102,915,752	108,867,099	110,255,345
% of the total	3.9%	1.5%	0.0%	93.3%	98.7%	100%

Source: Based on BDA data. Superintendence of Pensions.

In the case of the number of members (Table 3), it reaches around 12 million registered in the base of people affiliated to the system, with 2% not having a registered account. Of the rest, 4.6% are not included in the final sample, since they do not register a valid CCICO account, they are deceased or less than 18 or more than 110 years old.

Table 3. Distribution of members according to sex and filters of the sample. March 2016.

Sex	Without CCICO Account	With CCICO Account			Total
		Non Valid	Valid		
			Age <18 or >110	Age 18-110	
Men	32,367	398,249	14,780	6,037,060	6,482,456
Women	206,181	132,802	8,892	5,292,605	5,640,480
Total	238,548	531,051	23,672	11,329,665	12,122,936
% of the total	2.0%	4.4%	0.2%	93.5%	100.0%

Source: Based on BDA data. Superintendence of Pensions.

Regarding contributors, Table 4 shows that men dominate, representing 58% of total contributors compared to 42% for women. Additionally, funds B and C exhibit a greater proportion of overall contributors (34% and 32%). In relation to the average taxable wage, as observed in the labor market, women registered a lower level compared to men, with an average of $ 691,719, 15% lower than the average for men ($ 817,046). This difference is maintained through the different types of funds, being more pronounced in the taxable wage of those who quote in fund C and D, where women register levels 23% and 19% lower than men. Likewise, the highest taxable wage is recorded by male contributors in fund A and the lowest by female contributors in fund D.

Table 4. Distribution of contributors and average of taxable remuneration by sex and type of fund. March 2016.

Sex	Fund Type	Contributors		Taxable wage (average)
		Amount	%	
Women	A	306,652	5%	777,417
	B	855,466	15%	767,528
	C	699,246	12%	608,370
	D	294,215	5%	551,179
	E	203,420	4%	822,078
Men	A	480,021	9%	929,946
	B	1,079,333	19%	852,287
	C	1,093,644	19%	787,498
	D	324,092	6%	681,681
	E	310,966	6%	898,210
Total		**5,647,055**		**755,391**

Source: Based on BDA data. Superintendence of Pensions.

The differences in the total of contributors and taxable remunerations presented, and those reported in the Statistical File published regularly by the Superintendence of Pensions, would be due to the fact that in the Statistical File active members that are quoted in the informed month are reported. This means that only the remunerations reported in the month prior to the report are presented, while the statistics in Table 4 correspond to all the remunerations accrued in the month, regardless of the date on which they are reported.

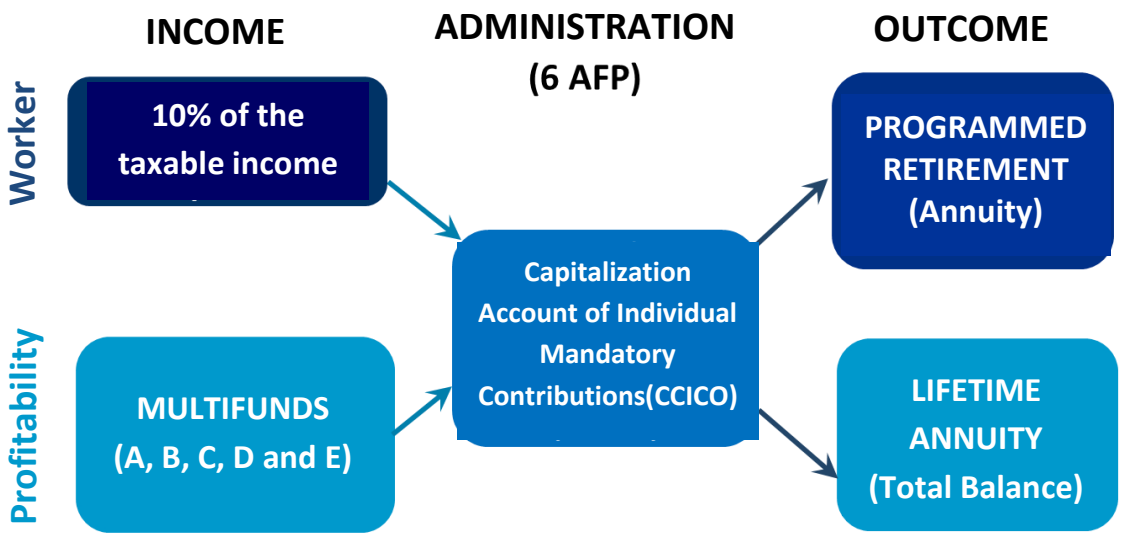
To summarize, at the starting point of the projection of funds, March 2016, the number of members would be concentrated in men (53%), a group that also exhibits a greater proportion of the total accumulated balance (68%). On the other hand, funds B and C have the highest number of members (32% and 30%, respectively) and the highest cumulative balance ratio is observed in fund C (35%).

Regarding the contributors, these are mostly men (58%), who also exhibit a higher taxable salary than women (18% higher), and with savings concentrated in funds B and C (34% and 32%, respectively).

Methodology

Empirical Strategy

In the pension system it is possible to identify members in two possible states: active or inactive. While the former may or may not contribute in a particular period, the latter are retired and they do not contribute.[1]



Members are grouped according to sociodemographic cells, that is, an index according to sex, age and type of fund, both for contributors and pensioners. For simplicity, people join at age 18 and contribute up to 110. In addition, all members contribute up to the legal retirement age, that is, men up to 65 and 60 in the case of women.

The categories considered are those that have the greatest impact on accumulation. Regarding sex, there are important differences in the levels of accumulation between men and women, both because of the existing wage gap and differences in the levels of labor market participation. Likewise, the de-accumulation path is different due to the mortality tables by sex used at the moment of the calculation of the pension, which reflect the difference in life expectancy.

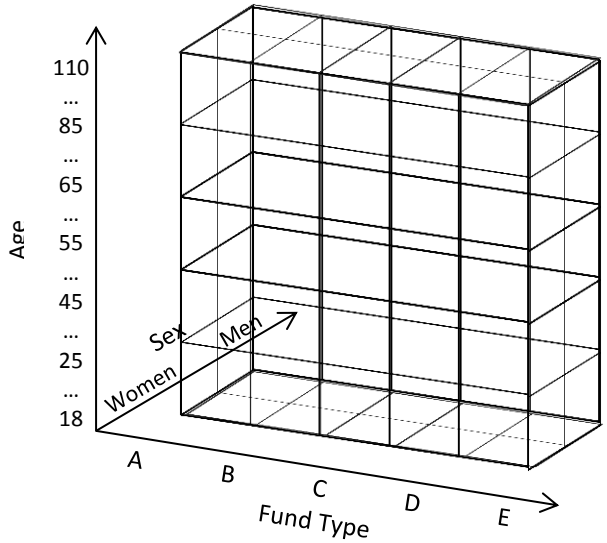
In terms of age, there is a salary growth curve associated with experience, both for men and women, as well as a lower participation in fertile ages for the latter.

Regarding the type of fund, the creation of the multifunds in 2002 allowed the members to decide on the investment of their funds among 5 alternatives with different levels of risk. Thus, the allocation of the contributions to the different funds is a determining factor in the profitability

[1] Those members (or affiliates) who died or do not have the right to inform are not considered, which correspond, at March 2016, 6% of members dataset.

obtained by members, directly impacting the accumulated balance. From 2002 to 2016, the funds have rented between 6.13% annually (real rate), for the case of fund type A and 3.92% for fund E.

Therefore, it is possible to construct a "cube" of 2 (sex) x 93 (age) x 5 (type of fund). From these indexes, the number of members, the accumulated balance in the CCICO[2], average remuneration and proportion of contributors in each of the cells at March 2016 are obtained. For the latter, only contributors who earn remunerations in the month of observation are included.



Regarding the relevant parameters for pensioners, the indicators use the data between January and August of 2017, in particular the proportion of the balance and members according to pension modality. For simplicity, only old-age pensioners are analyzed, given that in 2016, for example, they accounted for 96% of pension requests for old age. Respect to the type of modality selected by these pensioners, Life Annuities (RV), Temporary Income with Life Annuity (RT + RV) and Programmed Retirements (RP) represent 99.9% of the total[3]. The first two are considered as RV for the purpose of accumulation of the model.

The screening is done annually. In each period (t), the values of the relevant variables of the cells of an age (e), sex (s) and type of fund (f) are the result of the changes (product of quotes, profitability, new affiliations, retirements, death, among others) of the cell the previous year (t-1), one year lower in age (e-1), of the same sex (s) and same type of fund (f).

$$Cell_{t,s,f,e} = \Delta * Cell_{t-1,s,f,e-1}$$

The projection is carried out in a horizon of 23 years, with an annual periodicity, being representative of the month of March of each year.

[2] It is discarded to incorporate other accounts, such as Voluntary Saving, Volunteer Affiliation, among others. This is due to the complexity of the modeling in relation to the low importance (4%) of the total funds.

[3] The other types of pension are advanced old age and disability. As for the modality, there is the Programmed Retirement plus Life Annuity (RP + RV) that represents 0.08% of the requests in 2016.

Model

In a simple model of income/expenses, the balance of the pension funds in a period t, is determined by the profitability of the funds, the contributions of the active members, the benefits paid in pensions and the transfers to the companies of insurance in the case of RV. However, these variables vary according to the age of the persons, their sex, the type of fund in which they save their funds and in the period of the working life in which they find themselves.

In this way the value of pension funds (FP) in a given period (t) will be the sum, through all the cells (age (e) -sex (s) -type of fund (f)) in that period.

$$FP_t = \sum_{s=1}^{2} \sum_{f=1}^{5} \sum_{e=18}^{110} Saldo_{t,s,f,e}$$

Whereas:
Sex 1: woman, 2: men
Fund Type 1: A, 2: B, 3: C, 4: D, 5: E
Age: 18-110

The balance of each period and cell is determined by the accumulated balance of previous periods, its profitability, the pension benefits that are paid, in the case of pensioners and the contributions for the case of active members.

$$Balance_{t,s,f,e} = Balance_{t-1,s,f,e-1} * \left(1 + r_f\right) - Pension_{t-1,s,f,e-1} + Cot_{t,s,f,e} * Rem_{t,s,f,e} * 12 * tcot$$

Whereas, $Pension_{t-1,s,f,e-1}$ is the total amount of pension received by all the members, one year younger, the previous year. This pension is calculated as an equivalent life annuity, which will have the same value each period. In the case of active members, under 61 for women, or 66 for men, it takes the value 0.

$$Pension_{t,1,f,e} = \frac{Balance_{t,1,f,61}}{CNU_{t,1,61}} \; \forall \; e = 61 \ldots 110$$

$$Pension_{t,2,f,e} = \frac{Balance_{t,2,f,66}}{CNU_{t,2,66}} \; \forall \; e = 66 \ldots 110$$

$CNU_{t,1,61}$ is the Necessary Unitary Capital (CNU) at time t, for women at age 61. $CNU_{t,2,66}$ is the CNU at time t, for men at age 66.

$Cot_{t,s,f,e}$ is the number of contributors in the corresponding cell, which is determined by a fixed proportion ($prop\_cot_{t_0,s,f,e}$) observed in the base period of the projection (t_0). For the case of ages over the legal retirement age, this proportion is 0.

$$Cot_{t,s,f,e} = prop\_cot_{t_0,s,f,e} * Members_{t,s,f,e}$$

$$prop\_cot_{t_0,s,f,e} = \frac{Cot_{t_0,s,f,e}}{Memebers_{t_0,s,f,e}}$$

$Rem_{t,s,f,e}$ is the average monthly taxable wage of the previous period, for the members one year younger ($Rem_{t-1,s,f,e-1}$) multiplied by the observed annual growth rate ($g\_rem_{(t_0,t_{-1}),s,f,e}$), for the cell sex/type-of-fund/age, for the base period (March 2016 (t-1) and March 2017 (t0)).

$$Rem_{t,s,f,e} = Rem_{t-1,s,f,e-1} * (1 + g\_rem_{(t_0,t_{-1}),s,f,e})$$

$$g\_rem_{(t_0,t_{-1}),s,f,e} = \frac{Rem_{t_0,s,f,e}}{Rem_{t_{-1},s,f,e}} - 1$$

Regarding the members in each period and cell, these are determined by the group of members of the same cell the previous year and one year younger ($Members_{t-1,s,f,e-1}$) and a growth factor that represents, growth of the population (g_pob) constant for every cohort, and growth of members (new affiliations, for young ages, people moving to a different fund and deaths in the case of pensioners) ($g\_members_{t_0,s,f,(\Delta e_0,)}$).

$$Members_{t,s,f,e} = Members_{t-1,s,f,e-1} * (1 + g\_pob\ ) * (1 + g\_members_{t_0,s,f,(\Delta e_0)})$$

$$g\_members_{t_0,s,f,(\Delta e_0,)} = \frac{members_{t_0,s,f,e_0}}{members_{t_0,s,f,(e_0-1)}} - 1$$

For new members, who turn 18 in the projected year, particular parameters are assumed for the growth of salaries, growth of the population, and their balance will be determined by the contributions of the period.

$$memberl_{t,s,f,18} = member_{t-1,s,f,18} * (1 + g\_pob\ )$$

$$Rem_{t,s,f,18} = Rem_{t-1,s,f,18} * (1 + g_{rem}\ )$$

$$Saldo_{t,s,f,18} = Cot_{t,s,f,18} * Rem_{t,s,f,18} * 12 * tcot$$

After calculating the balance and the members for all the sex-type fund-age cells, legal restrictions apply in relation to the types of fund in which certain groups of members can allocate their savings. In particular, members women (men) over 50 (55) years old cannot have their savings in fund A and older than 60 (65) cannot allocate them to fund B.

Thus, in each period, for cells where people with savings in fund A or B meet the ages where the restrictions above became active, the average taxable remuneration is recalculated and its members and their balances are redistributed. The rule follows the unrestricted funds distribution observed for the same period: women (men) over 50 (55) in fund A move to funds B, C, D, E; women (men) over 60 (65) in the fund B move to funds C, D and E.

At the legal retirement age, there is a group of members that will withdraw their funds from the system to contract RV.

$$Balance_{t,1,f,61} = Balance_{t,1,f,61} * p\_balance\_rp_{t_0,1,f,61} \qquad f = 3,4,5$$

$$Member_{t,1,f,61} = member_{t,1,f,61} * p\_member\_rp_{t_0,1,f,61} \qquad f = 3,4,5$$

$$Balance_{t,2,f,66} = balance_{t,2,f,66} * p\_balance\_rp_{t_0,2,f,66} \qquad f = 3,4,5$$

$$Member_{t,2,f,66} = member_{t,2,f,66} * p\_member\_rp_{t_0,2,f,66} \qquad f = 3,4,5$$

$p\_balance\_rp_{t_0,1,f,61}$ is the proportion of the total balance of the group of members in fund f (3, 4, 5) that opt for RP pension modality in 2016.

$p\_member\_rp_{t_0,1,f,61}$ is the proportion of members in fund f (3, 4, 5) that opt for RP pension modality in 2016.

$p\_balance\_rp_{t_0,2,f,66}$ is the proportion of the total balance of the group of members in fund f (3, 4, 5) that opt for RP pension modality in 2016.

$p\_member\_rp_{t_0,2,f,66}$ is the proportion of members in fund f (3, 4, 5) that opt for RP pension modality in 2016.

Additionally, after retirement, using the current mortality tables, a proportion of members that die, which are removed from the system, is calculated. However, their funds are maintained, assuming that this balance will finance eventually survival pensions.

$$Members_{t,1,f,e} = Members_{t,1,f,e} * pr\_survival_{t,1,e} \quad e > 60$$

$$Members_{t,2,f,e} = Members_{t,2,f,e} * pr\_survival_{t,2,e} \quad e > 65$$

Projection Scenarios

Different projection scenarios are assumed based on the return of pension funds.

The returns calculated for the pension simulator of this Superintendence are used. These are obtained based on 2,000 monthly series of simulated returns according to an investment horizon of 40 years, for each of the 5 multifunds.

These returns are obtained by mapping the structure of pension funds into eight asset classes: national variable income; foreign equity of developed countries and emerging countries; government and corporate national fixed income; national financial intermediation; foreign fixed income developed and emerging. For each of these classes it is assumed that the returns follow a Brownian process with diffuse jumps, which incorporate the possibility of financial crises occurring. The probability of crisis used is 6.5% per year. For the implicit annuity rate, a similar process is estimated.

Thus, three scenarios are considered, described in Table 5.

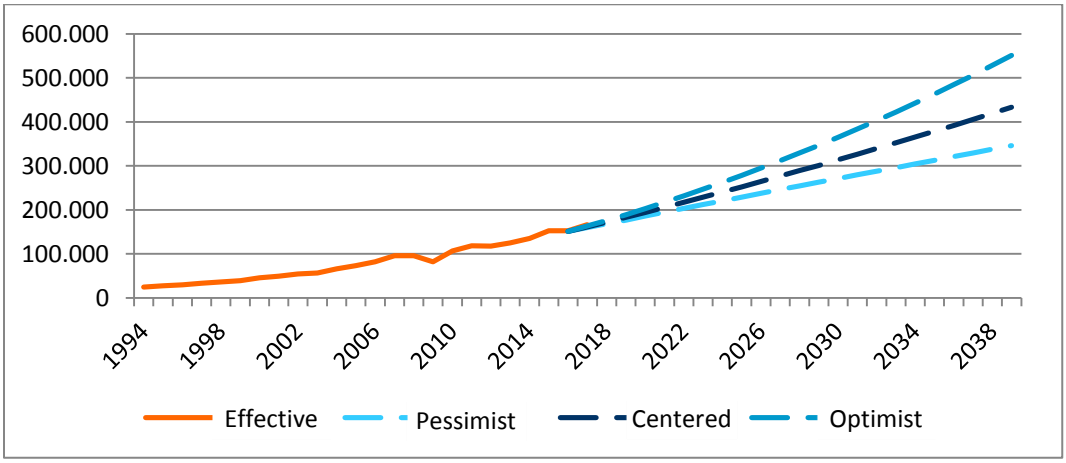
Table 5. Return of pension funds and annuity rate according to projection scenarios.

Fund	Pesimist (P5)	Centered (Average)	Optimist (P95)
A	2.97%	5.75%	8.49%
B	3.06%	4.89%	6.72%
C	3.03%	4.15%	5.28%
D	2.82%	3.53%	4.23%
E	2.50%	3.00%	3.51%
RV Rate	3.30%	3.36%	3.43%

Results

According to the different returns and annuity rates, pension funds were projected for three scenarios: optimistic, central and pessimistic. In the central scenario, there is an increase in pension funds of 183% between March 2016 and March 2039, from USD 153 billion to USD 433 billion. This increase is 57 p.p. lower in the case of a pessimistic scenario and 77 p.p. higher in the case of the pessimistic scenario, reaching USD 346 billion in the first case and USD 551 billion in the second case (Chart 3).

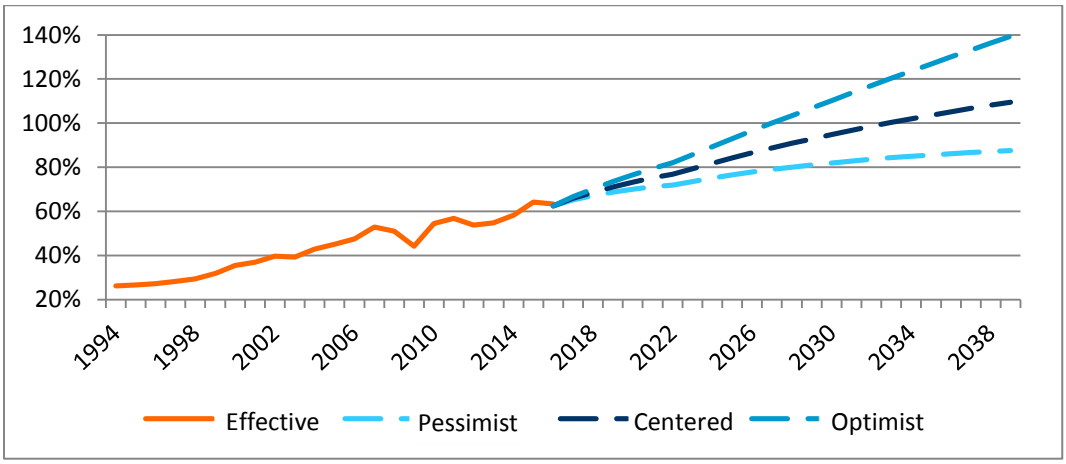
Figure 3. Evolution and projection of the value of the pension funds 1994-2039. Different scenarios. In millions of dollars.



Source: Superintendence of Pensions. Administrative records and Pension Fund Projection Model.

Regarding the proportion of the value of the funds in relation to the GDP, by 2016 this represents 67%. The model projects an increase of 42 p.p. in the central scenario, reaching 109% of the GDP, 88% in the pessimistic scenario, 139% in the optimistic case, in the year 2039 (Chart 4).

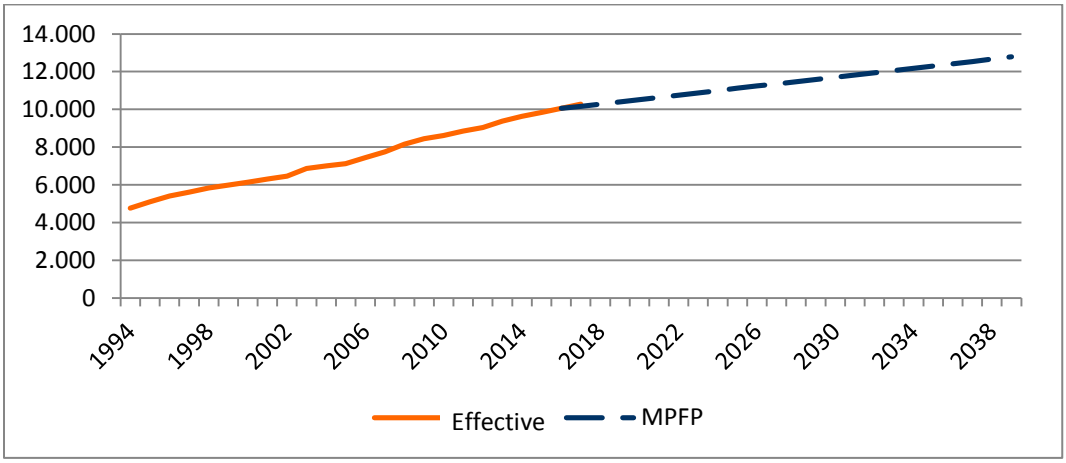
Figure 4. Evolution and projection of the value of pension funds on the GDP. 1994-2039. Different scenarios.



Source: Superintendence of Pensions. Administrative records and Pension Fund Projection Model.

With regard to members, a total of 12.8 million members are projected for the year 2039, which is equivalent to an increase of 27% with respect to 2016 (Chart 5).

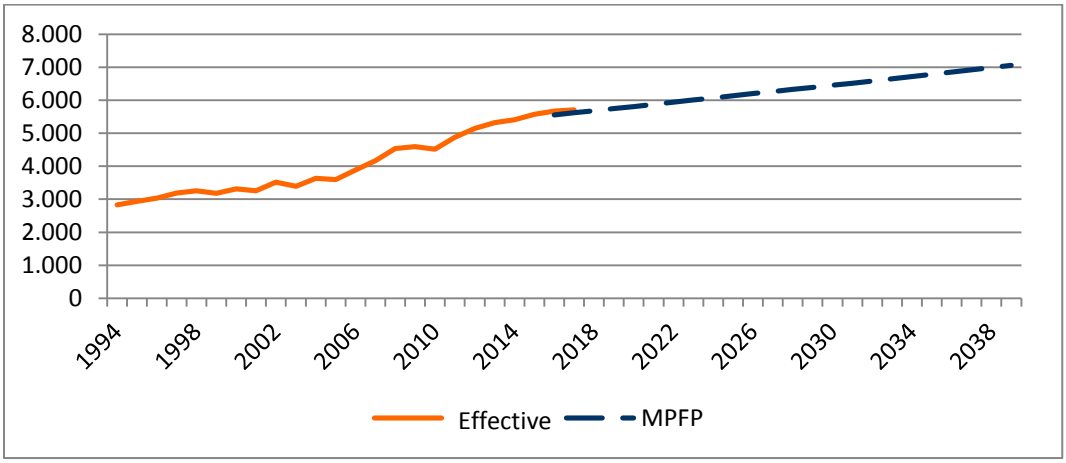
Figure 5. Evolution and projection of active members. 1994-2039. In thousands of people.



Source: Superintendence of Pensions. Administrative records and Pension Fund Projection Model.

Regarding the contributors, an increase of 25% is projected between 2016 and 2039. Moving from 5.8 million contributors to 7 million. These correspond to 55% of active members, a figure that is maintained through the projection.

Figure 6. Evolution and projection of contributors. 1994-2039. In thousands of people.



Source: Superintendence of Pensions. Administrative records and Pension Fund Projection Model.

Flexibility of the model

Given the main results above, the central scenario is used as the baseline to compare with projections obtained changing other relevant parameters, to highlight the malleability of the model.

The exercise considers three new scenarios and the results are shown in chart 7.

First, the contribution density is pushed to 100% for all active members through the projection horizon (100%-density scenario). In terms of the model, this implies to force $prop\_cot_{t_0,s,f,e} = 1$. This scenario implies an important increase in the accumulated funds, being 50% higher than the central scenario in 2039.

The second scenario models an increase in women affiliation to be the same as for men (affiliation-like-men scenario). In terms of the model, this implies to force $g\_members_{t_0,s,f,(\Delta e_0,)} = \frac{members_{t_0,2,f,e_0}}{members_{t_0,2,f,(e_0-1)}} - 1 \; \forall \; s = 1,2$

This scenario exhibits lower accumulation of funds than the central scenario, mainly because the observed growth rate of men is smaller than women's growth rate. Therefore, the growth of active female members is lower than in the central scenario.

Finally, the third scenario increases legal retirement age for women to 65 to pair with men, considering a growth of members and contribution profile for women similar to the observed between 61 and 65 years old (women-65 scenario). In terms of the model, this implies:

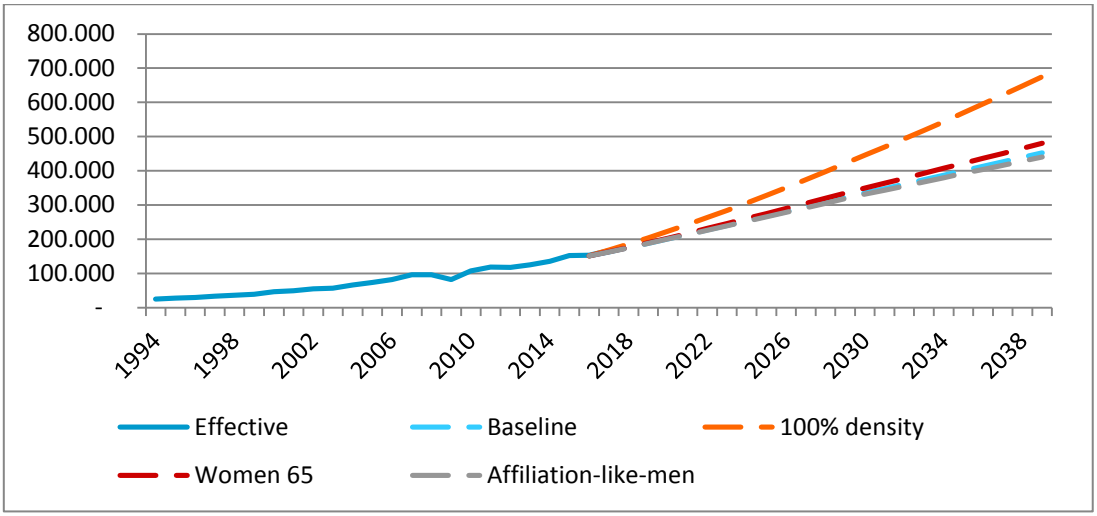
$$Pension_{t,s,f,e} = \frac{Balance_{t,s,f,66}}{CNU_{t,s,66}} \; \forall \; e = 66 \ldots 110 \;\; \forall \; s = 1,2$$

$$Balance_{t,s,f,66} = balance_{t,s,f,66} * p\_balance\_rp_{t_0,s,f,66} \qquad f = 3,4,5 \; \forall \; s = 1,2$$

$$Member_{t,s,f,66} = member_{t,s,f,66} * p\_member\_rp_{t_0,s,f,66} \qquad f = 3,4,5 \; \forall \; s = 1,2$$

The results show that pension funds are as higher as the baseline projection, about 7 percent points higher as a percentage of the GDP.

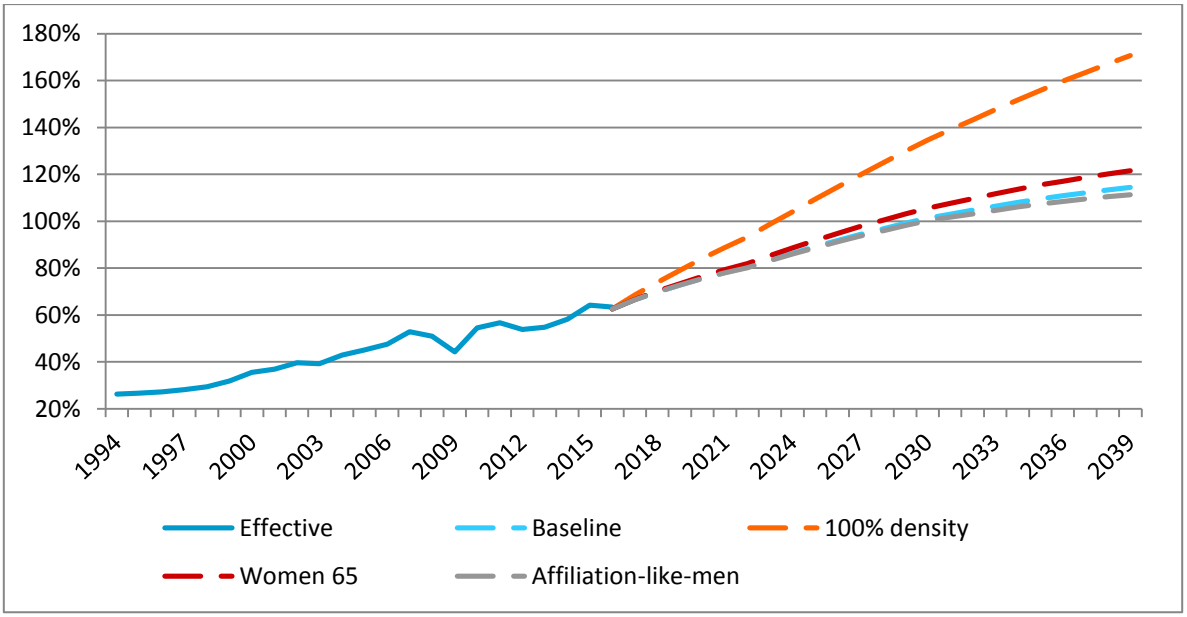
Figure 7. Evolution and projection of the value of the pension funds 1994-2039. Different scenarios. In millions of dollars.



The dominant effect among these three is the 100%-density scenario, generating an accumulation of funds 49% higher than the central scenario. Even if not very realistic, this scenario shows the potential of the system under total capacity.

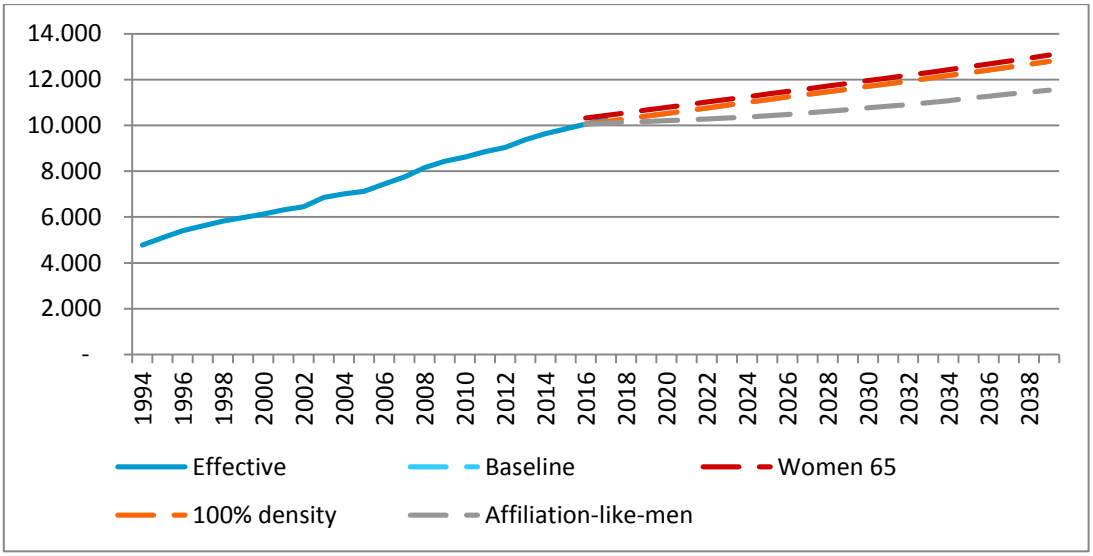
The last two scenarios related to parametric changes for women show little effects compared to the central scenario: the affiliation-like-men scenario generates accumulated funds 3% lower and the women-65 scenario, just a 6% higher.

Figure 8. Evolution and projection of the value of pension funds on the GDP. 1994-2039. Different scenarios.



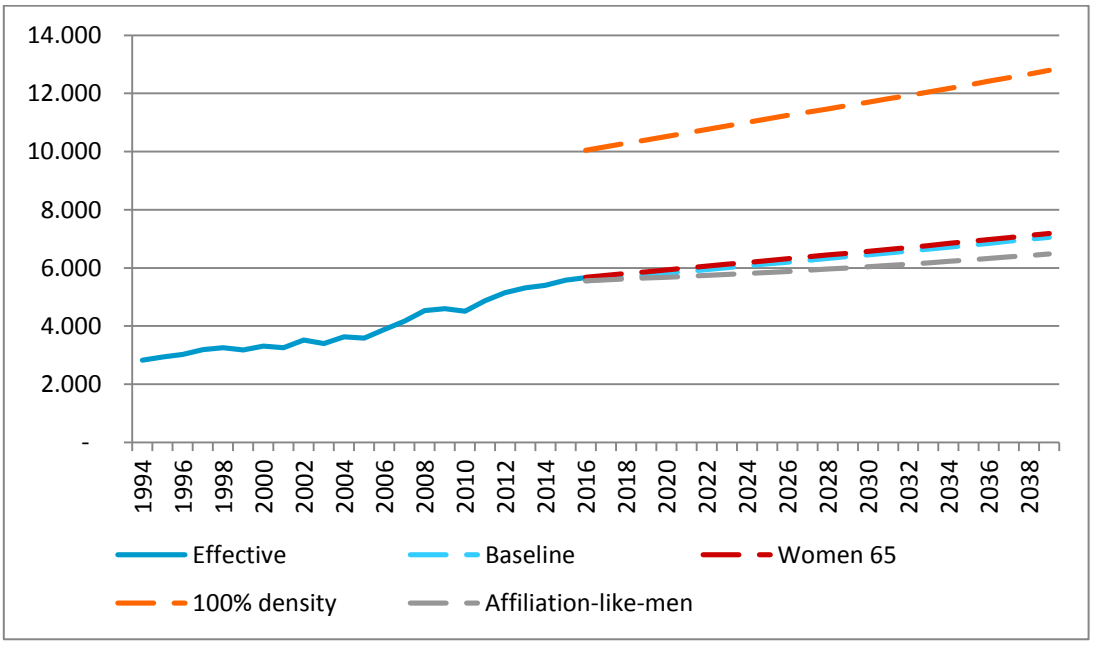
It is important to keep in mind that the 100%-density scenario could be also understood as an increased-participation scenario. In terms of programming and given the nature of the model, in both cases the number of people contributing in each cell is forced to be the total of members. With the model as it is programmed today it is not possible to disentangle the effects given they are contained in the same parameter. This is something to keep in mind if used for policy evaluation purposes.

Figure 9. Evolution and projection of active members. 1994-2039. In thousands of people.



Finally, there are differences between members and contributors projections for the 100%-density scenario: affiliation increases by 20% whereas contributors increased 100%.

Figure 10. Evolution and projection of contributors. 1994-2039. In thousands of people.



Conclusions

The proposed model is a contribution to the existing literature on projection models. Independent from the absence of variables that allow characterizing the population more accurately, using cells that group members' information from the existing characteristics contained in administrative databases, it is possible to project a comprehensive level for pension funds.

The above has a direct impact on the simplicity of the model, which allows replicating it to different areas that consider people and accumulation or use of resources. It is this characteristic that makes it a very efficient model from the point of view of the use of computational resources, since it obtains long-term results in a few minutes. Likewise, it highlights its flexibility when evaluating factors that affect the level of pension funds, since it is possible to parameterize different determinants that impact the accumulation of pension funds.

These characteristics allow us to establish future challenges that will make the model even more sensitive. It is possible to modify both the income variables: rate and density of contribution, as well as those of retirement: retirement age and pension type, to name a few.

Finally, in this first approach to the projection of pension funds in Chile it is possible to establish that they grow at increasing rates over time, within the band given the different returns scenarios used to raise awareness of the level of accumulation.

Annexes

Annex 1. A and B Fund Restriction.

In the case of the first restriction, for funds B, C, D, E:

$$prop_{t,1,f,51} = \frac{members_{t,1,f,51}}{\sum_{f=2}^{5} members_{t,1,f,51}}$$

$$prop_{t,2,f,56} = \frac{members_{t,2,f,56}}{\sum_{f=2}^{5} members_{t,2,f,56}}$$

$$Rem_{t,1,f,51} = \frac{Rem_{t,1,f,51} * members_{t,1,f,51} + Rem_{t,1,1,51} * members_{t,1,1,51} * prop_{t,1,f,51}}{members_{t,1,f,51} + members_{t,1,1,51} * prop_{t,1,f,51}}$$

$$Rem_{t,2,f,56} = \frac{Rem_{t,2,f,56} * member_{t,2,f,56} + Rem_{t,2,1,56} * members_{t,2,1,56} * prop_{t,2,f,56}}{members_{t,2,f,56} + members_{t,2,1,56} * prop_{t,2,f,56}}$$

$$members_{t,1,f,51} = members_{t,1,f,51} + members_{t,1,1,51} * prop_{t,1,f,51}$$

$$members_{t,2,f,56} = members_{t,2,f,56} + members_{t,2,1,56} * prop_{t,2,f,56}$$

$$Cot_{t,1,f,51} = prop\_cot_{t_0,1,f,51} * members_{t,1,f,51}$$

$$Cot_{t,2,f,56} = prop\_cot_{t_0,2,f,56} * members_{t,2,f,56}$$

$$Balance_{t,1,f,51} = Balance_{t-1,1,f,50} * (1 + r_f) + Balance_{t-1,1,1,50} * prop_{t,1,f,51} * (1 + r_f) + Cot_{t,1,f,51} * Rem_{t,1,f,51} * 12 * tcot$$

$$Balance_{t,2,f,56} = Balance_{t-1,2,f,55} * (1 + r_f) + Balance_{t-1,2,1,55} * prop_{t,2,f,56} * (1 + r_f) + Cot_{t,1,f,56} * Rem_{t,2,f,56} * 12 * tcot$$

In the case of the second restriction, for funds C, D, E:

$$prop_{t,1,f,61} = \frac{members_{t,1,f,61}}{\sum_{f=3}^{5} members_{t,1,f,61}}$$

$$prop_{t,2,f,66} = \frac{members_{t,2,f,66}}{\sum_{f=3}^{5} members_{t,2,f,66}}$$

$$Rem_{t,1,f,61} = \frac{Rem_{t,1,f61} * members_{t,1,f,61} + Rem_{t,1,2,61} * members_{t,1,2,61} * prop_{t,1,f,61}}{members_{t,1,f,61} + * members_{t,1,2,61} * prop_{t,1,f,61}}$$

$$Rem_{t,2,f,66} = \frac{Rem_{t,2,f,66} * members_{t,2,f,66} + Rem_{t,2,2,66} * members_{t,2,2,66} * prop_{t,2,f,66}}{members_{t,2,f,66} + * members_{t,2,2,66} * prop_{t,2,f,66}}$$

$$members_{t,1,f,61} = members_{t,1,f,61} + members_{t,1,2,61} * prop_{t,1,f,61}$$

$$members_{t,2,f,66} = members_{t,2,f,66} + members_{t,2,2,66} * prop_{t,2,f,66}$$

$$Cot_{t,1,f,61} = prop\_cot_{t_0,1,f,61} * members_{t,1,f,61}$$

$$Cot_{t,2,f,66} = prop\_cot_{t_0,2,f,66} * members_{t,2,f,66}$$

$$Balance_{t,1,f,61} = Balance_{t-1,1,f,60} * (1 + r_f) + Balance_{t-1,1,2,60} * prop_{t,1,f,61} * (1 + r_f) + Cot_{t,1,f,61} * Rem_{t,1,f,61} * 12 * tcot$$

$$Balance_{t,2,f,66} = Balance_{t-1,2,f,65} * (1 + r_f) + Balance_{t-1,2,2,65} * prop_{t,2,f,66} * (1 + r_f) + Cot_{t,1,f,66} * Rem_{t,2,f,66} * 12 * tcot$$

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