A new pension system in Brazil? An evaluation of the fiscal and distributive impacts of the 2019 pension reform proposal

Luís Eduardo Afonso

lafonso@usp.br

Associate Professor
University de São Paulo

João Vinícius de França Carvalho

jvfcarvalho@usp.br

Assistant Professor
University de São Paulo

Abstract

In 2019 the Brazilian government proposed a very comprehensive pension reform in Brazil, the Constitutional Amendment 6. Based on this fact, in this paper we calculate the fiscal and distributive impacts on the General Social Security Regime (*RGPS*). This is done using a microsimulation actuarial model that calculates contributions, old-age and survivors' benefits over a period of 30 years. The approval of the reform would reduce expenses from BRL 13.42 trillion (USD 3.34 trillion) to BRL 10.59 trillion (USD 2.64 trillion) in the three decades analyzed. Net pension liabilities would fall from BRL 5.99 trillion (USD 1.49 trillion) to BRL 3.43 trillion (USD 0.85 trillion). The Replacement Rates would drop from 73.99% to 67.65%. The Required Contribution Rates would reduce from 42.70% to 32.87%. The Internal Rates of Return would have a reduction of 2.37% to -1.00%. The Average Old-Age Duration would fall from 19.45 to 16.46 years. These results provide strong evidence that the reform contains the right measures, but it is insufficient in the long run.

Keywords: social security, pension reform, RGPS; retirement, distributive aspects

1. Introduction

In early 2019 Jair Bolsonaro assumed the presidency of Brazil. As rarely seen before, the country's fiscal situation was very serious. This imbalance was mainly caused by the social security deficit, which has increased considerably in recent years. Given this worrying situation, the Brazilian government presented in February 2019 the Proposed Constitutional Amendment 6 (*CA 6/2019*), a very comprehensive pension reform proposal.

The social security deficit is Brazil's most serious economic problem. In 2018, the RGPS revenue was BRL 391 billion (USD 97 billion) against an expenditure of BRL 587 billion (USD 140 billion), meaning a deficit of BRL 196 billion (USD 47 billion). For 2019, these amounts should be equal, according to preliminary results, to BRL 419 billion (USD 104 billion), BRL 637 billion (USD 159 billion), and BRL 218 billion (USD 54 billion), respectively. The social security balance is a *sine qua non* condition to equate the public finance. This is fundamental for Brazil to grow sustainably. The country is decades behind what has been done in other nations. The Brazilian fiscal crisis has a basic reason: the pension imbalance.

This study aims to calculate revenues, expenses, results, and the pension liabilities for the Social Security General Regime (*RGPS*), for the next 30 years. Three pension indicators (*Replacement Rate, Internal Rate of Return, and Required Contribution Rate)* are also calculated in order to quantify the distributive aspects. For this purpose, a non-behavioral actuarial microsimulation model using microdata from the National Household Sample Survey (*PNAD*) was built on two conditions: *Current Situation* (effective in September/2019) and *New Rule* (given by the original version of CA 6/2019, the *Bolsonaro Reform*).

This study is expected to provide support to policy makers in the pension area in Brazil. We intend to contribute to the public debate on this subject with adequate reasoning, shedding light on the costs and benefits of the government's measures, in the present and the future. A pension reform involves a complex set of elements that must be analyzed together. Recent literature (Chybalski, 2016; Damon, 2016; ISSA, 2015) advocates that pension systems should be analyzed in a multidimensional way. More specifically, the performance of these systems (Pallares-Miralles, Romero, & Whitehouse, 2012) comprises multiple elements that lead to the calculation of several pension indicators of established use in the literature.

Carrying out reforms in pension systems and to adapt them to economic and demographic characteristics is one of the biggest challenges for almost all countries. Brazil is not an exception. Between 2009 and 2015, all 34 OECD countries carried out some type of reform (OECD, 2015). In general, the changes are motivated by the process of population ageing due to demographic transition, originating from the non-synchronized reduction in mortality and fertility rates, with effects that last for decades. Applying the metaphor of Schwarz et al. (2014), there is an inversion in the age pyramid, with an increase in the top part (elderly) in relation to the intermediary parts (economically active population) and the bottom (young).

There is a consensus in the literature (Bloom & McKinnon, 2010; Coleman, 2006; Acosta-Ormaechea, Espinosa-vega, & Wachs, 2017; Amaglobeli et al., 2019) that such demographic alterations have a negative impact on the pay-as-you-go regimes. In addition, these alterations generate a tendency to increase expenses against the revenues, for two reasons: first, the increase in the number of elderly in relation to the number of actives, with an increase in the dependency ratio; and second, the increase in the period of receipt for the pension benefits. The pension must be modified to prevent the expenses from being too burdensome for future generations. For example, Spain and Greece, which presented severe fiscal imbalances, made more radical reforms in their pension systems (Díaz-Giménez & Díaz-Saavedra, 2016, section 1; Symeonidis, 2016).

Pension systems are an integral part of social protection mechanisms. They have four objectives (Barr & Diamond, 2006): intertemporally smoothen consumption, function as an insurance mechanism, reduce poverty, and serve as a mechanism of income redistribution. Usually, social

security systems are organized as a combination of pay-as-you-go regime with defined benefits. Alternatively, the other possibility is the fully funded, defined contribution regime.

This paper is divided into five sections, including this short introduction. Section 2 describes the main characteristics of the RGPS and the most relevant measures of the CA 6/2019 original version. The next section describes the methodology of the developed microsimulation model. The main pension indicators are also presented. Section 4 reports the results. The last section presents the conclusions.

2. Social Security in Brazil: Current Situation and the CA 6/2019

2.1. RGPS Current Situation

The Brazilian social security system has three components. The first, object of our analysis, is the General Social Security Regime (RGPS). The second is composed of the federal, state and local pension plans of civil servants. The third component is the military's pension system. CA 6 does not include the military. This paper analyzes only the RGPS. The RGPS comprises all employees and self-employed workers in the private sector, as well as some public sector workers with a formal contract.

The RGPS deficit is aggravated by some peculiarities and various distortions. The first is the over indexation of the pension floor (in which 70% of the benefits are included) to the minimum wage (Giambiagi & Afonso, 2015). The second is an unusual characteristic of the Brazilian pension system: the existence of two types of old-age benefits, by Age (AB) and by Length of Contribution (LCB), both with high replacement rates: 96% for the AB and 82% for the LCB (Afonso, 2016). For the AB, there is a reduced contributive incentive because the amount of the welfare benefit is the same and the condition of eligibility for the AB is not very strict: only 15 years of contribution, with a minimum age of 65 for men and 60 for women. For rural workers, the ages are reduced by five years. For the LCB, there is only one requirement: a contribution period of 35 years for men and 30 for women. There is a major distortion: the LCBs are granted on average at the age of 56 (53) for men (women). This implies a period of receipt of the benefit well above the international average. This scenario is aggravated by the fact that the workers who retire by length of contribution have higher income, schooling, and insertion in the formal labor market, in addition to the prevalence of the male gender. The fourth factor is the lack of strict rules for the survivors' benefit (Rocha & Caetano, 2008), even with the alteration in the duration of the benefit, subject to the age of the spouse, made in 2015.

While the first three factors are due to the choices of the policy makers, the fourth factor, population ageing, is exogenous. From 2000 to 2016, the proportion of elderly (65 years old or over) changed from 5.61% to 8.17% of the population. In the same period, the proportion of RGPS beneficiaries increased more than proportionally, changing from 11.28% to 16.38% of the population. This scenario is expected to worsen in the future with an accelerated population ageing that will take Brazil to have 15.5% of elderly by 2035.

2.2. Constitutional Amendment 6/2019: Main Measures

Brazil's government forwarded the CA 6/2019 to Congress on February 20, 2019. This is the most comprehensive and ambitious proposal of social security reform in Brazil. In general lines, the diagnosis basing the CA 6 is very consistent. A reform of such magnitude is justified by the urgent need to reduce the deficits and the actuarial asset, from either the RGPS or the federal, state and local pension plans of civil servants (RPPS). At the same time, the reforms aim to reduce the inequalities in treatment between the beneficiaries of the several regimes as well as inside each regime. The CA 6 marks a break in the view that has prevailed since the 1988 Federal Constitution. A significant part of the social security elements (and of the pension system in particular) will no longer be part of the constitutional text and will be defined by ordinary legislation.

Although the CA 6 has been dealt with as an only piece, its measures can be divided into three major groups: *Managerial measures*, *Parametric reform*, and *Non-parametric reform.* The first group aims to reduce fraud and evasion. The second group is a parametric reform, which alters some relevant parameters of the RGPS pay-as-you-go regime, in the federal, state and local RPPSs, and in welfare benefit for elderly and disabled persons (BPC-LOAS). The third group is a non-parametric reform, with the possibility of establishing a fully funded or a notional defined contribution regime to replace the current pay-as-you system. When this paper was being completed, the CA 6 was being analyzed in the Legislative.

This work focuses on the measures of the parametric reform in the RGPS, as they are the key element of this proposal of change. The description presented herein refers to the CA 6 original wording, whose main measures are the following:

- Unification and increase in the progressivity of the contribution rates for the RGPS and the RPPS;
- Unification of the eligibility conditions for retirement in the RGPS and RPPS;
- Unification of the old-age benefits: the Age Benefit (AB) and the Length of Contribution Benefit (LCB) will no longer exist in the RGPS. There will be only one type of old-age benefit, in which the eligibility conditions are age and a minimum contribution period of 20 years;
- Alteration in the eligibility conditions for rural retirement;
- Alteration in the eligibility conditions for teachers, and;
- New rule to calculate the value of the old-age benefit for the RGPS and the RPPS.

The CA 6 greatly simplifies the formula for calculating the old-age benefit in two ways. The first is by merging the rules for the workers in both the public and private sector. The second is by imposing a simple rule to calculate the benefit, presented in equation 1. The amount of the benefit is calculated based on the average of the 60% highest *salaries of contribution*, added with an accrual rate of 2% per additional contributive year. During the transition period (which varies by gender and position in the occupation), the sum cannot be over 100%, meaning that the maximum number of years considered is 40 (20 years of minimum requirement added to 20 years of additional period). When the transition is complete, the percentage can be over 100%. In any of the cases, the amount is limited to the minimum and ceiling of the RGPS. There is also another change. In the current situation, the average *M* is calculated over the 80% highest salaries of contribution. In the CA 6, the average is calculated over the entire contribution period.

$$\textit{Old-Age Benefit} = 0.6*\textit{Average} + 0.02*\textit{Additional Years}*\textit{Average} \quad (1)$$

Even so, there are still some differences in treatment according to the insertion in the labor market. The first refers to the urban/rural dichotomy. In the RGPS, the urban retirement is granted with a minimum age of 65 for men and 62 for women, together with a minimum contribution period of 20 years for both. For the rural workers, the eligibility condition is of 60/55 (M/W) with 15 years of rural activity, changes for the age of 60 (men and women) with 20 years of contribution. This change binds the granting of the benefit to the flow of contributions effectively made and not only to the period of rural activity, which does not necessarily imply contributions to the pension system, in addition to increasing the minimum requirement from 15 to 20 years.

The second difference occurs to teachers. The minimum age for this group will be of 60 years old (men and women), but the contribution period will be 30 years for both genders.

A critical point in any reform is the transition period. It is necessary to meet the objectives of increasing the system's sustainability while transition rules are created - rules that preserve, somehow, the expectancy of rights in the regime to be altered. There is a basic principle that the closer the worker is to retirement, the less the worker should be affected by the reform. This generates a clear trade off. The less the current generations are affected by the reform, the lower the immediate fiscal impact of the measures.

In the reform proposed, all those already receiving old-age and survivors' benefits, or who already complied with the minimum requirements to retire (although not doing so), will not be affected. Thus, they will keep receiving the benefits (first group) or will have the right to retire with the conditions of the current rule as soon as they want to (second group). Consequently, the burden of the reform falls on the younger groups, given that the elderly have the benefits, the eligibility condition, and the formula to calculate the benefit preserved.

Unlike the previous reform proposals, there are three transition rules for the Length of Contribution Benefit and one rule for the Retirement by Age benefit of the RGPS, valid for those already in the labor market. In this second case, the beneficiary will be able to choose the most beneficial rule. These rules only apply to the eligibility condition. Even for these workers, the pension value will be calculated according to the accrual rate previously defined. The four transition rules are as follows:

a) The Points Rule (sum of length of contribution and age)

In this first case, the first requirement is the length of contribution of 35/30 years (M/W). In addition, the sum of age and length of contribution must be met, which starts at 96 points for men and 86 points for women. For teachers, the amounts are reduced by five points, increasing one point per year, until men reach 105 points in 2029 and women reach 100 points in 2033. For teachers, the amounts are five points lower.

b) Age Rule

In this second case, the minimum age of retirement starts at 61(56) in 2019 and increases six months each year until reaching the age of 65 for men (2028) and 62 for women (2031). For teachers, the initial numbers are five years lower. The final number is equal (62 years old) and is reached in 2031.

c) Increase of 50% over the time needed for LCB ("Toll")

The third possibility is applied only to those who, on the possible date of approval of the CA, need less than two years to retire. In other words, men and women with at least 33(28) years of contribution. The teachers are supposed to fit into this rule when at 28(23) years of contribution, given that their contributive requirement is five years less than of the other workers. For those fitting in this rule, there would be an increase of 50% over the remaining time. Unlike the previous two rules, the pension factor is applied to calculate the benefit. It is also assumed that in this rule, the average is calculated in the current way: 80% of the highest salaries of contribution and not the entirety of the period, as in the previous two cases.

d) Rule by age and length of contribution (Retirement by age)

This last transition rule applies only to Retirement by Age. The requirements of contribution period and age will increase until they reach, respectively, 65(62) and 20 years. For men, there is no increase in age, because with the CA 6 there will not be an increase. For women, the increase is only two years. Due to this, the transition for age is completed in only two years. However, because the contribution period increases 6 months per year, the age element regarding this rule will increase for 10 years, until 2029.

There are also changes to the survivors' benefit. In the current rule, when the reversion is to the spouse and dependents, the pension amount is 100% of the benefit from which it was originated. In the CA 6, it is proposed that the pension amount be equal to 50% + 10% per dependent, up to the limit of five dependents. It is also proposed that there be limits to the accumulation of benefits. The beneficiary would have the right to 100% of the highest benefit, plus a percentage of the other benefit. This is reduced by 20% for each beneficiary, up to a limit of four.

The RGPS and RPPS contribution rates will be unified and become more progressive. The lowest rate for monthly salaries of contribution (SC) up to BRL 998.00 (USD 249) will be 7.5%. The

following rates will be, respectively, 9.0%, 12.0% and 14.0% for SC up to BRL 2,000.00 (USD 498); up to BRL 3,000.00 (USD 747), and up to BRL 5,839.45 (USD 1,454). Thus, the maximum effective rate will be 11.68%.

There are other changes to the disability benefits, to the welfare benefits (particularly for the BPC-LOAS), forecasting for a non-parametric reform with the subsequent establishment of a fully funded regime (even with the doubt about the notional regime), removal of the 40% fine of the Guarantee Fund for Length of Service (FGTS) for already retired workers, and segregation of the health, social security and social assistance budgets. However, because these changes are out of the scope of this work, they are not described in more detail.

3. Methodology

3.1. General Considerations

This study adopts the non-behavioral actuarial microsimulation methodology. From individual records, we built the path of contributions and social security benefits for each individual throughout the forecast period. This is done for both the set of rules currently in force and for the reforms proposed in the CA 6.

These amounts are summed, for each individual, for each year, to achieve the aggregate results of revenues and expenses of the social security system. In other words, the focus moves from the *individual* to an *aggregated* focus, with the intention of analyzing the impact of the measures on the government's fiscal result, the main focus of the adopted measures. Moreover, it is important to note that this methodology is called *non-behavioral* because it does not incorporate eventual changes in the individual decisions arising from the proposed measures. For example, it is considered that a civil servant will not migrate to the private sector if the retirement rules become less favorable in the public sector. However, we can infer that such assumption does not significantly alter the results.

3.2. The Model

The model applied in this work follows a tradition in the literature on pensions (Prammer, 2018; Morrill & Westall, 2019) in the use of microdata. Such models require many stages. As previously mentioned, because the National Household Sample Survey (PNAD) 2015 is a cross-section sample survey (as there are no public panel data available), the methodology for forecasting the contributive flows and benefits from microdata is a critical aspect to be observed. The model of this work can be divided into seven big parts, described as follows.

3.2.1. Reading microdata and initial procedures

The first step is the reading of the PNAD. 78 variables are applied, such as age, income, gender, insertion in the labor market, education, contribution to the social security, receipt of benefits, and family condition. These individuals are the basis for the forecasting to be carried out, as well as to calculate the pension indicators.

3.2.2. Identification of the RGPS Beneficiaries (active and inactive)

After the initial reading, the next step is to identify the active workers (possible RGPS beneficiaries in the future), divided into four categories: wage earners from the private sector; non-statutory workers from the public sector, i.e., workers who are legally employed and therefore contribute to the RGPS pension; self-employed individuals; and employers.

For employees, it is crucial to calculate the pension contributions in the initial year by applying the contribution rates in force at the time (employee and employer) to the reported incomes, respecting the upper and lower limits of the contribution salaries provided for in legislation. For the other two categories, it is necessary to make some assumptions, given that these workers can make contributions based on the income they wish. Considering that the beneficiaries of each category have a rather different profile (self-employed with lower income, very centered in 1 SM - minimum wage), distinct

hypothesis were adopted for both. We considered self-employed to contribute based on 1 minimum wage. For the employers, we assumed their contributions to be based on the income declared. Considering that wage earners are, by definition, legally employed, we assumed that their income and contributions have 13 annual installments. For the other two categories, only twelve installments were taken into account, for both the income and for the contributions (this information was obtained based on another variable, which informs the contribution to the pension system). The aggregation of the individual amounts of income and contribution, with the use of sample weights, allows us to achieve the amounts collected by the RGPS.

For the inactive, a more elaborate procedure is necessary. The PNAD primary variables only inform if the respondent receives an old-age or survivors' benefit and the amount of that benefit. It is not possible, *a priori*, to know if the benefit is actually paid by the RGPS or if it is a benefit of some RPPS. At first, the benefits with an amount over the ceiling of the RGPS are separated. It is assumed that these are from some RPPS. Next, based on the Social Security Statistical Bulletin (BEPS), the old-age and survivors' benefits are counted by contribution period, by age, by Minimum Wage group for September 2015, date of PNAD 2015 collection, and the amount verified. Based on this information, a sampling procedure of the Minimum Wage group from the PNAD benefits is made, so that the sum of the sample weights of the beneficiaries is equal to the quantities reported in the BEPS.

3.2.3. Imputation of deaths, forecasting income and contributions

After doing the initial attribution of old-age and survivors, the most complex part of the simulation starts. This is the forecasting of the amounts for all the relevant variables, whether monetary or quantitative during the forecasting period. There are several elements, many of which are linked to each other. Each individual is attributed with / assigned a probability of death, by gender and age, with the use of the Brazilian Institute of Geography and Statistics (IBGE) 2015 Mortality Tables, by gender. However, these tables are truncated at the age of 80. This age is very low; especially considering the objective is to forecast the expenditures and revenues for a relatively long period. In view of this, we carried out an extrapolation with the use of a Gompertz Function, presented in equation 2 (where *i* is the gender). For women, the best adjustment occurred with the use of four parameters in the function (generic case). For men, the adjustment occurred with the use of three parameters ($b_0 = 0$). In both cases, we adopted the terminal age ω of 115 years. Thus, it was possible to cover the entire lifespan expected from the sample components.

$$ {}_tP_{x,i} = b_0 + b_1 * e^{-e^{(-b_2*(age-b_3))}} \quad (2) $$

In this model, the biometric risk is incorporated through the occurrence of probabilistic deaths and not by the average life expectancy, as adopted in other studies. Each year, there is a random draw of the sample individuals, by gender and age. A number is associated in the interval]0.1[, based on a uniform distribution. The associated number is compared to the probability of imputed death. If the number is higher than this probability, the individual remains alive. If it is equal or lower, the person is dead. In this case, it is necessary to verify the individual's family condition (described later) for the possible generation of survivors' benefit for the dependents.

Considering that the granting of survivors' benefit is a key element of social security expenditure, it is necessary to identify the worker's family condition to assign the eligibility conditions of the dependents. The PNAD questionnaire has a question about the condition of the person in the family. This condition is attributed to each individual with the characteristics of the head of the family, spouse and children being relevant to the objectives of the study. For these three cases, the granting and the maintenance of the survivors are generally subject to the age of the dependents when the worker dies. As previously indicated, the CA 6 defines stricter conditions; its incorporation to the program is explained in more details in the next section.

The following step is to attribute the income of the workers for the period of forecasting through a Mincer equation, in the standard form of the literature. Thus, it is possible to evaluate the income of the worker *i* for all *t* years analyzed. Based on Brazil's literature (Giambiagi & Afonso, 2009), we used a real growth rate of 2% per year, in line with what is expected for a country like Brazil in the long term.

Based on the work of Afonso (2016), a contributive density (DC) is attributed differently by income bracket. The objective is to incorporate into the model, innovatively in Brazil's literature, the fact that workers do not contribute during their entire active life, even when having some source of income. In other words, workers can shift between the occupations described in the previous item when they contribute to the RGPS and to other occupations when they don't contribute. This might occur due to a change to some RPPS (i.e., they become civil servants), for situations of informality or unemployment or discouragement. Although conceptually these situations are distinct, in practice and for the purposes of this study, the result is the same: the non-existence of contributions to the RGPS in some periods of life. Therefore, we used three contributive densities (0.8; 0.7 and 0.5). Random numbers between zero and one are generated and compared (for each individual and each month throughout their active life) with the three critical amounts presented. If the random number is lower, then in that month that individual not only had a positive income, but also contributed to the RGPS.

The calculation of income and contributions is made monthly (due to the PNAD's microdata structure) and annualized to calculate the aggregate amounts. For wage earners, we considered 13 amounts of income per year (because of the thirteenth salary). For employers and self-employed, we considered only 12 contributions because by nature, they have no employment contract. It should be noted that, because the contributive density is less than 1, the contributions actually made are lower than the number of remunerations in the year. Considering that the original data is from 2015 and Bolsonaro's Reform starts from 2019, in that period the contribution rates were attributed each year, because they are already known. The same happens for the minimum wage amounts, the floor and ceiling of the contribution, in addition to the RGPS benefit. For the following years, we opted to maintain the amounts that implicitly correspond with the maintenance of its real amount. In Bolsonaro's Reform, the contribution calculation takes into account the progressive rates mentioned in the CA 6/2019, previously presented. For the Current Situation, the rates in force at the time of writing this text are valid.

3.2.4. Granting and Calculation of Old-Age benefits

The granting and the calculation of old-age benefits are carried out separately, according to the different conditions of labor market insertion and rules to calculate the benefit. Below are the eight categories of workers, based on the two main types of benefits: retirement by length of contribution and by age. This division is necessary because workers in the current situation have distinct eligibility conditions.

- Old-Age benefits by age
  - Urban – Men
  - Urban – Women
  - Rural – Men
  - Rural – Women
- Old-Age benefits by length of contribution
  - Urban – Men
  - Urban – Women
  - Urban – Male Teachers
  - Urban – Female Teachers

For each individual, every year it is verified if they have reached the minimum requirement to retire (age and/or contribution period). If this happens, the record receives a flag indicating that the worker is retired. The premise of the model is that retirement occurs as soon as the eligibility

conditions are fulfilled. For teachers and non-teachers, the categories are exclusive, because it is a non-behavioral model. In other words, if the individual is at a certain position in the beginning of the study, he/she will remain so until retirement.

This procedure generates the flow of retirements granted each year. However, two adjustments are necessary to align this flow to the actually verified experience of granting. The first refers to the aggregate flow. The premise of retirement as soon as the minimum requirement of eligibility is met causes the first year of simulation to have a high number of new retirements. This occurs because a significant number of workers are already eligible to retire. Due to this, a flow dispersion procedure is used in the first years of the simulation. Experience has shown that the procedure has to be done for around 10 years in order to avoid discontinuity in the series of granting. The second procedure refers to the way the model attributes to the types of benefits and is related to the proportion verified between retirements by length of contribution and by age. *A priori* it is not possible to know if a worker will retire by age or by length of contribution. In view of this, the granting is calculated for both types. It is possible that at first, the same individual may obtain both retirements, or also, that the relationship between the number of benefits granted may not adhere to the historical experience. Both inaccuracies are corrected through the imputation of a random number, arising from a uniform distribution. This number is compared with a threshold, according to the experience of granting. For the cases that meet both eligibility requirements and/or have an overlap in both types, a benefit reclassification is carried out. This guarantees that each individual receives only one old-age benefit and that the proportion between the two types is respected.

For the CA 6, the procedure is the same. However, the task is substantially more complex due to the existence of four rules of transition with distinct durations for men and women; urban and rural workers; teachers and non-teachers; retirements by length of contribution and by age.

For each type of benefit, gender, insertion in the labor market and rule of transition, the eligibility condition is checked every year. If any condition is reached in any rule, the worker is classified as retired. There is a significant number of workers who reach more than one condition of retirement by contribution period, in some of the rules. For this reason, the premise is assumed that the beneficiary retires as soon as he/she achieves the first condition of eligibility. Similarly, it is necessary to check if the condition of retirement by age was met. However, it is essential to compare the four rules to attribute the type of benefit, and further calculate the amount of benefit. Just as it was done for the Current Situation, it is necessary to compare the estimated flows with the actual required flows to, if needed, reallocate types of benefits for each individual (provided that the individual has reached the required condition to retire). This procedure is carried out in two parts. The first covers the entire transition period. The second is done in the steady state, when the transition has already been concluded. Be reminded that this transition period has a different duration for men, women, male and female teachers, for the retirements by length of contribution and by age, and for rural workers. It is also important to highlight that the eligibility conditions are stricter during the transition period for the retirements by contribution period. Once the attribution of old-age benefits is concluded, the amount of the benefit is calculated. This operation is subject to the period of transition, according to the provisions of the CA. While it lasts, there is a limit to the average salaries of contribution used.

3.2.5. Calculation and Distribution of Survivors' Benefits

After the old-age benefits have been granted and the amounts calculated, year by year, the next step is to calculate the survivors. For this, it is necessary to incorporate the family condition (head or spouse) and the existence of dependents (existence of spouse and children, as well as their ages), because to revert the old-age into survivors takes into account the family structure to verify eligibility. In the Current Situation, the reversion is integral. In the case of the CA 6, the amount is subject to the number of dependents, so the maximum reversion is 100%. In the case of death or loss of condition of one dependent, there is no reversion to the other members of the family, which causes the amount to decrease gradually.

This implies that every year it is necessary to calculate the deaths of retirees, check the existence of dependents, and allocate the amounts to estimate the flow of new survivors. In addition, it is also required to check every year, if the eligibility condition for each one is still valid to recalculate the amount, if needed.

3.2.6. Entering of New Workers in the Labor Market

The next stage is to insert the new workers in the database. This part of the procedure involves several steps. The first step is to impute several generations of 16-year-old individuals (minimum age to contribute to the pension system), one generation each year, to simulate the natural entrance of new workers in the labor market. Each incoming individual receives a sample weight as well, so that their data is compatible with those in the sample. The number of workers inserted has to be compatible with the number of individuals under the age of 16 originating from the PNAD, by gender.

After inserting the new workers, the next step is to attribute to them the required characteristics. The most relevant is the position in the occupation and the income. At first, this is done using the characteristics of the previous generations as proxy. However, additional care is taken. Empirical evidence shows that, for lower ages, there is an over representation of informal workers because young individuals enter in the labor market in low quality positions, partly because they are less qualified. If this characteristic were reproduced over time, it would tend to generate a volume of contributions lower than that actually verified, overestimating the deficit in the long term. To avoid this, although the entry occurs at the age of 16, at each later age, the attribution of the position in the occupation considers the proportions actually verified in 2015. This procedure is done until the age of 25. From the age of 26, the position in the occupation and its status as a contributor are fixed.

The second step is to impute the income. For each of the five categories of workers, we calculate an average income and the standard deviation by gender and by age. Based on that information, a Normal distribution of those incomes are generated. Amounts of this Normal distribution are used to attribute the income to the new workers. Next, the contributions of these workers are calculated, according to the rules and added to the contributions of the other beneficiaries.

3.2.7. Aggregation of Forecasts and Main Results

Last step consists of aggregating all previously calculated results, by year and gender: flows and stocks of quantities and values of benefits and contributions. Thus, expenditures and revenues of the RGPS are calculated in the forecast period.

3.3. Pension Indicators

This study calculated the following pension indicators traditionally used in the literature on pensions (Palacios & Pallares-Miralles, 2000; Whitehouse et al., 2000).

Replacement Rate (*RR*)

This corresponds to the ratio between the first old-age benefit B_{it}, received by individual i at time t and the last income prior to his/her retirement $W_{it-1.}$ (Equation 3). It is an immediate indicator of adequacy, i.e., the capacity the pension system has to replace the income upon retirement. However, the fact that it does not take into account the duration of the periods of income receipt and of the contributions, means that intertemporal aspects, intrinsic to the pension systems, are not collected. In view of that, it is necessary to calculate other indicators such as money's worth measure (Leimer, 1995; Mitchell, Poterba, & Warshawsky, 1999). These indicators are used, for example, by Knell (2009) and Lüthen (2016).

$$RR_i = \frac{B_{it}}{W_{it-1}} \tag{3}$$

Required Rate (*ReqRate*)

The Required Contribution Rate (*ReqRate*) represents what the rate of the worker's income should be, so that the expected present value of benefits *PVB* is equal to the expected present value of income *PVI*.

$$ReqRate_i = \frac{\sum_{t=N+1}^{\omega} \frac{B_{it}}{(1+r)^t}}{\sum_{t=1}^{N} \frac{R_{it}}{(1+r)^t}} = \frac{PVB_i}{PVI_i} \quad (4)$$

Internal Rate of Return (*IRR*)

The term on the left of Equation 5 is the present value of the contributions C_{it} (made by each worker *i* at time *t* and discounted at the *IRR* rate), called *PVC*. The sum starts at the first contribution. The term *N* corresponds to the last contribution period. For the benefits B_{it}, the sum starts at the period *N+1*, when there is the receipt of the first benefit, extending until the terminal age ω. This sum is the *Present Value of Benefits PVB*. The *IRR*, by definition, is the rate that equalizes the flows of the two sides of the expression.

$$VPC_i = \sum_{t=1}^{N} \frac{C_{it}}{(1+TIR)^t} = \sum_{t=N+1}^{\omega} \frac{B_{it}}{(1+TIR)^t} = VPB_i \quad (5)$$

Average Retirement Duration (*AveDur*)

This indicator measures the average duration of the old-age benefits from the moment of granting until the date of the retiree's death. Using a nomenclature adopted by the RGPS, the indicator corresponds to the difference between the Benefit Cessation Date (*BCD*) and the Benefit Start Date (*BSD*).

$$AveDur_i = \sum_{i=1}^{N} \frac{(BCD_i - BSD_i)}{N} \quad (6)$$

Gross Pension Liabilities (*GPL*)

This aggregate indicator quantifies the present value of expenditure with old-age and survivors' benefits, for *T* years for all *P* beneficiaries.

$$GPL = \sum_{i=1}^{P} \sum_{t=1}^{T} \frac{B_{it}}{(1+r)^t} \quad (7)$$

Net Pension Liabilities (*NPL*)

The *GPP* is a relevant but imperfect indicator, because it does not adequately reflect the magnitude of the required effort to finance the pension benefits. For this reason, another aggregate indicator was also calculated, the *NPL*. The *NPL* calculates the difference for *T* years, between old-age and survivors' benefits and contributions, for all the *P* contributors and beneficiaries, at present value. The calculation is a proxy of the intertemporal solvency of the RGPS. Both are elaborated based on the concepts of Gross Social Security Wealth (SSWG) and Net Social Security Wealth (SSWN), presented in the classic text of Feldstein (1974, p. 911).

$$NPL = \sum_{i=1}^{P} \sum_{t=1}^{T} \left(\frac{B_{it} - C_{it}}{(1+r)^t} \right) \quad (8)$$

4. Results

Firstly, the descriptive statistics are presented. Then, the fiscal and individual indicators are reported.

4.1. Descriptive Statistics

Table 1 shows some characteristics of the PNAD's sample of workers used in the calculations. Table 2 presents the average amounts of the RGPS retirements and pensions and the average amounts of income, separated by gender. The relationships between the retirements, pensions and the average incomes are also presented. This is an approximate indicator of the systemic replacement rate of the RGPS. To to facilitate the understanding of the values, all values are presented in Reais (BRL) and dollars (USD). We used the average exchange rate from 21 to 25 September 2015, when the PNAD data was collected.

Table 1 – Labor market characteristics (2015)

Position in the occupation	N	%	Contributors	Income		Years of
			(%)	(BRL/month)	(USD/month)	study
Formal employee	36,825,347	41.26	100.00	1,741	434	10.07
Military	354,739	0.40	100.00	3,216	801	11.72
Statutory Public Servant	6,973,272	7.81	100.00	3,408	849	12.68
Informal employee	13,411,278	15.03	23.97	1,167	291	8.53
Formal housekeeper employee	2,016,149	2.26	100.00	991	247	7.11
Informal housekeeper employee	4,292,518	4.81	11.99	633	158	6.60
Self-employed	21,823,126	24.45	26.25	1,441	359	7.60
Employer	3,550,566	3.98	70.29	5,151	1283	10.79
Total	89,246,995	100.00	64.19	1,781	444	9.23

Table 2 – Monthly income, old-age and survivors (BRL and USD/month)

Gender	Income		Old-age		Survivors		Retirement/Income	Pension/Income
	(BRL)	(USD)	(BRL)	(USD)	(BRL)	(USD)	(%)	(%)
Male	1,885	469	1,290	321	934	233	68.44	49.53
Female	1,356	338	1,082	269	1,065	265	79.80	78.55
Total	1,672	416	1,184	295	1,047	261	70.80	62.61

4.2. Pension Indicators

This section presents the results of the empirical procedures and simulations, previously described. Sections 4.2.1 to 4.2.5 show the five individual Pension Indicators.

For the Pension Indicators, the presentation of the results always follows the same standard. Firstly, a table is presented with the average amounts for the Current Situation and the New Rule, for the Old-Age Benefits. The amounts are given in three situations: the full Sample, for the Age Benefit (*AB*) and for the Length of Contribution Benefit (*LCB*). In each case, the results are also disaggregated by gender. Next, there is a set of six histograms that show the distribution of the indicator amounts. Both the Current Situation and the New Rule have three graphs. The first histogram (blue bars) contain the results for the entire sample. The second (red bars), reports the amounts related to the *LCB*s. Finally, the last graph (green bars) shows the *AB* amounts.

All the indicators went through a Winsorization process in order to prevent the outliers from having more influence, especially over the visualization of the graphs. This is a standard procedure in the literature, as described for example, in Beaumont & Rivest (2009). In particular, a trimming process was adopted with 1% on each side of the amount distribution.

4.2.1. Replacement Rate (*RR*)

Table 3 reports the Replacement Rate (*RR*). The amounts show that the *RR*s should decrease about seven percentage points in the New Rule in relation to the Current Situation. The main reason for this result is the new rule for calculating the retirement benefits, which eliminates the Pension Factor and the 85/95 Progressive Rule and imposes only one way to calculate the retirement for all workers. When all the transition periods are finished and there is only one type of retirement, workers with identical profiles will have equal *RR*s (but the same will not occur with the other indicators, as in the next sections), even between men and women. The reason is that the new rule of calculation does not differentiate by gender (except for male/female teachers and rural workers).

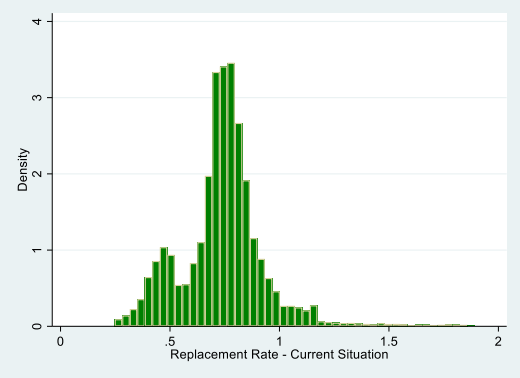
A significant reduction in the differences between *LCB* and *AB* can be observed. The prevailing differences have two explanations. First, the most relevant is that during a large part of the 30 years of simulation there are still transition rules in force, which end up covering workers with different insertion conditions in the labor market. The second, perhaps less determinant, is the maintenance of distinct enforceable conditions for male/female teachers and rural workers.

Next, in Graphs 1 to 6 there are two relevant aspects. First, there is a relatively high dispersion of results, particularly for the *LCB*s in the New Rule. Second, the dispersion should drop significantly, due to the unification of the rules to calculate the benefits, which will make RGPS less progressive, thus losing a significant part of its distributive characteristics (although this redistribution has the unwanted counterpart of large deficits).

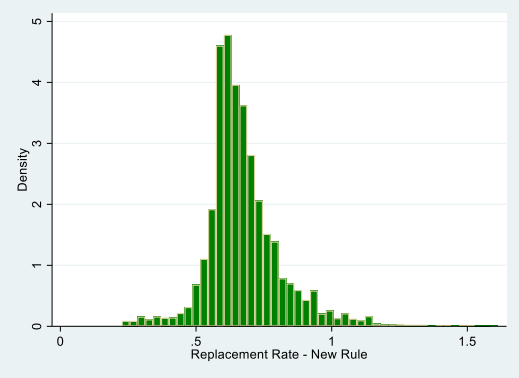
Table 3 – Replacement Rate (*RR*) by gender and type of old-age benefit
Current Situation and New Rule

Group	Current Situation (%)	New Rule (%)
Full Sample	73.99	67.65
Male	77.24	66.41
Female	69.88	67.94
Age (AB)	83.29	67.40
Male	83.26	67.22
Female	83.32	67.63
Length of Contribution (LCB)	64.74	68.31
Male	71.77	67.98
Female	54.84	68.65

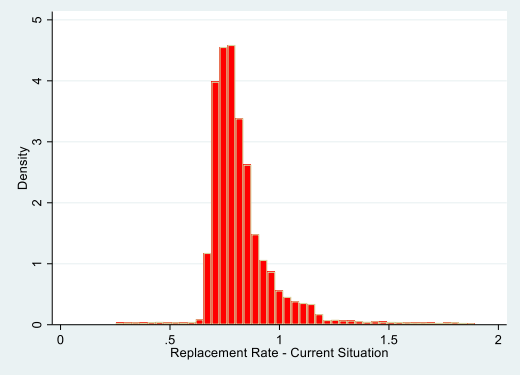
Graph 1 – Replacement Rate (*RR*)
Current Situation



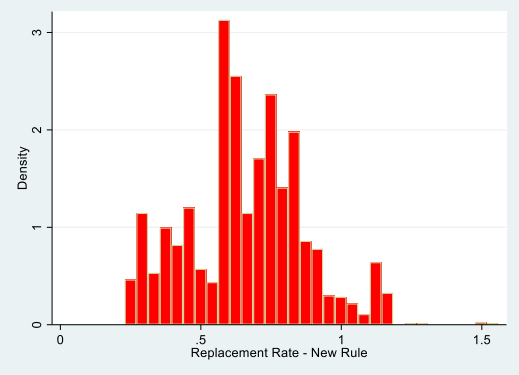
Graph 4 – Replacement Rate (*RR*)
New Rule



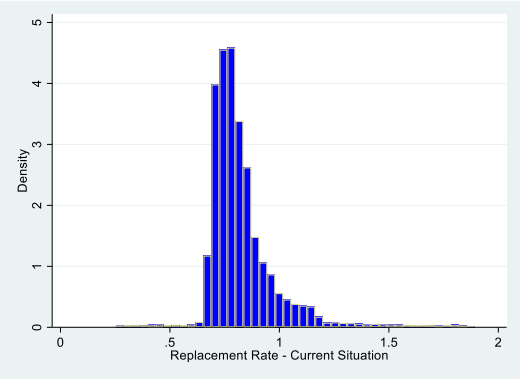
Graph 2 – Replacement Rate (*RR*) – LCB
Current Situation



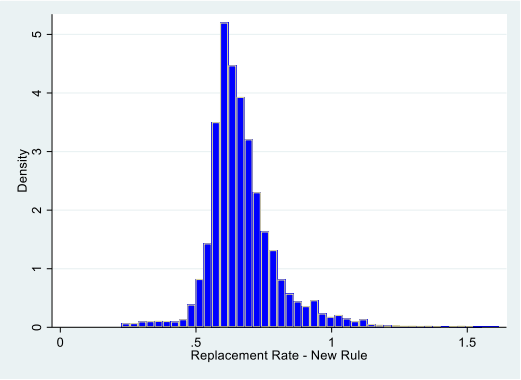
Graph 5 – Replacement Rate (*RR*) – LCB
New Rule



Graph 3 – Replacement Rate (*RR*) – AB Current Situation



Graph 6 – Replacement Rate (*RR*) – AB New Rule



4.2.2. Required Rate (*ReqRate*)

The second indicator is the Required Rate (*ReqRate*). Unlike the RR, which is a contemporary indicator (that is, it depends on only two amounts immediately subsequent to each individual, the income before the retirement and the amount of the first pension), for the *ReqRate* the procedure is more elaborate, given that it is calculated through two flows, the *Present Value of Income* (*PVI*) and the *Present Value of Benefits* (*PVB*).

The *PVI* calculation is the first item to be equated. As PNAD is a cross-section, whose amounts refer only to a certain instant in time, there is no information about the amounts of the variables in periods prior to 2015. To overcome this obstacle, the following procedure was adopted. In the PNAD, there is a question about the age the individual started working. This variable, together with the length of contribution already weighted by the contributive density, allows us to calculate the effective number of contribution periods to the pension. This is used as a proxy for the period of income receipt (and of contributions). As the *PVI* reference period is the retirement date, the income growth rate itself serves as a discount rate to calculate the income at present value. Next, the present values of old-age are calculated at present value with the use of this same discount rate. The two present values are then used to calculate the *ReqRate*.

Furthermore, an additional change is necessary to avoid distortion in the results. By definition, the *ReqRate* results depend on the calculation period of the *PVI* and *PVB* flows. For the *PVI*, the procedure described in the previous paragraph provides a way to get around this possible restriction. However, in order to avoid problems in relation to the *PVB*, the number of years of simulation needs to be extended. To clarify the point, let us take the example of a worker retiring in 2043. As the simulation finishes in 2044, this would mean an unreal period of receipt of only one year. For this reason, to calculate both this indicator and the others in this section, the simulation period was expanded to 60 years.

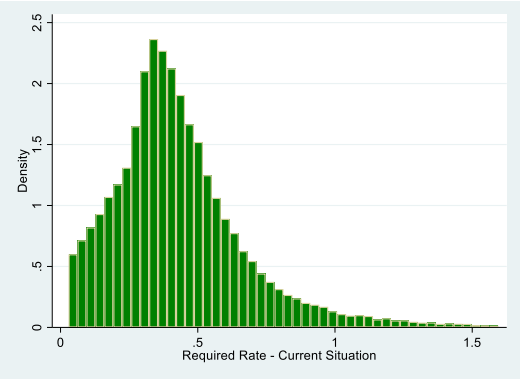
The data in table 4 show that in the Current Situation, the rates should be almost 43% in order to finance actuarially fair pension benefits. There is a clear heterogeneity between men and women and between the types of benefits. The amounts for women and for the *AB*s are always higher. The amounts for women are greatly influenced by their longer life expectancy, while the ABs amounts are highly related to the lower contributive requirement. In the New Rule, the average amounts drop by about 10 percentage points. For the ABs of the women, the reduction is over 23 percentage points. As a whole, these amounts indicate that the proposed reform is on the right path. However, as the amounts are still lower than the effective rates, it is possible to affirm that there is evidence that the changes have not yet been enough. Still, this conclusion should be made with caution, because a significant part of the simulation occurs during the transition rules.

Graphs 7 to 12 are next. Not only are the New Rule amounts lower, but it also can be observed that the results dispersion is lower. This is an expected result (and wanted) of the reform, deriving from the convergence of rules and conditions for retirement. It should be noted that in the New Rule, the proportion of workers with rates close to the unit is quite low, which is evidence that the changes in analysis will certainly increase the RGPS actuarial balance.

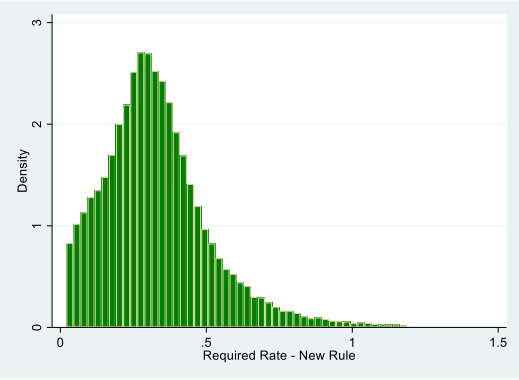
Table 4 – Required Rate (*ReqRate*) by gender and type of old-age benefit
Current Situation and New Rule

Group	Current Situation (%)	New Rule (%)
Complete Sample	42.70	32.87
Male	36.59	28.00
Female	50.44	39.02
Age (AB)	50.08	31.86
Male	40.14	28.24
Female	61.53	38.68
Length of Contribution (LCB)	35.47	33.47
Male	33.38	27.27
Female	38.38	39.75

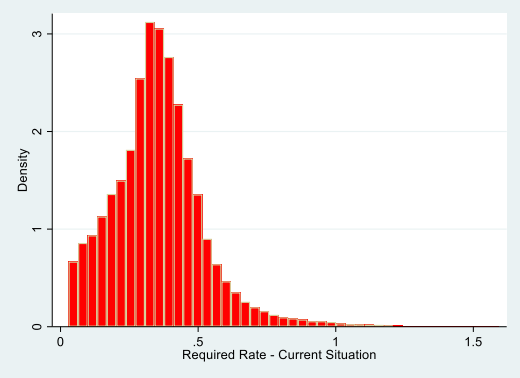
Graph 7 – Required Rate (*ReqRate*)
Current Situation



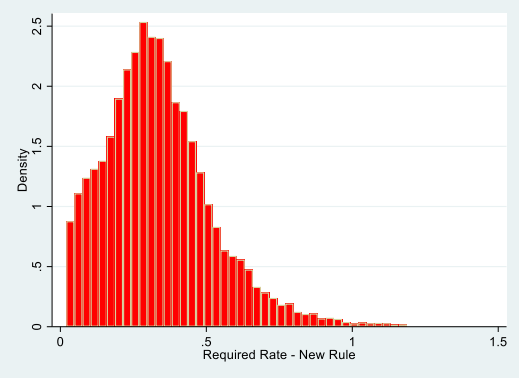
Graph 10 – Required Rate (*ReqRate*)
New Rule



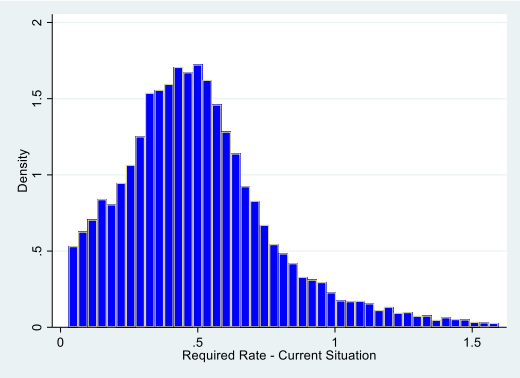
Graph 8 – Required Rate (*ReqRate*) LCB
Current Situation



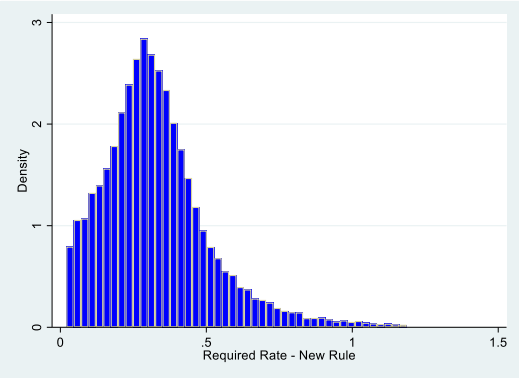
Graph 11 – Required Rate (*ReqRate*) LCB
New Rule



Graph 9 – Required Rate (*ReqRate*) – AB Current Situation



Graph 12 – Required Rate (*ReqRate*) New Rule



4.2.3. Internal Rate of Return (*IRR*)

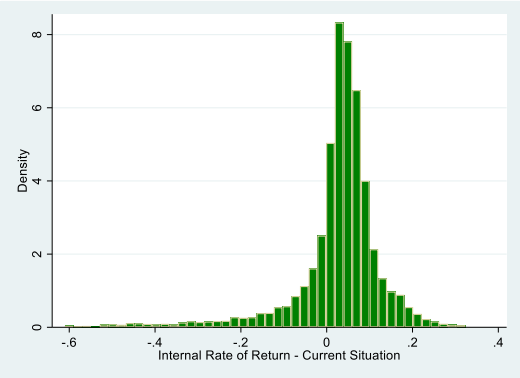
The third indicator is the Internal Rate of Return (*IRR*). Again, it is necessary to explain the procedure carried out for the calculation, similar to that adopted for *ReqRate*. As Equation 5 shows, the *IRR* is the rate that equalizes the present values of contributions and benefits (*PVC* and *PVB*). However, there is no information about past details or about the income. Nonetheless, it is possible to infer the *PVC* through the Effective Rate (*AliqEfe*) amount calculated by Afonso (2016). In the study, the *AliqEfe* obtained is quite constant for the two types of benefits and for the two genders, with an average amount of 27.34%. This amount multiplied by *PVI* allows us to get a proxy *PVC*. The amount is used to build, for each individual, a flow of payments and receipts from which the *IRR*s are calculated by an iterative process. The results show only the workers who retired before 2044 and who have a positive duration of pension receipt.

Table 5 shows the results. For the Current Situation, as has already occurred with the other indicators, the results are quite heterogeneous by gender and by type of benefit. For the male *LCBs*, the amount is less than zero, which is in line with previous evidence (Penafieri & Afonso, 2013) that, for this group, the pension system is close to balance. The average amount (2.37%) is a little higher than the amounts reported in similar studies, for younger generations and higher income (Clingman, Burkhalter, & Chaplain, 2019). For the New Rule, the results were surprisingly lower (being negative for several groups) and heterogeneous (being probably more influenced by the different life expectancies by gender than by *ReqRate*).

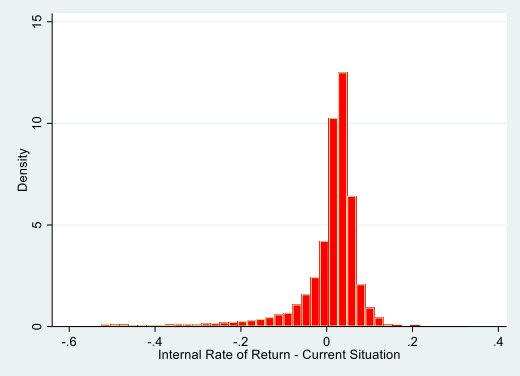
Table 5 – Internal Rate of Return (*IRR*) by gender and type of old-age benefit Current Situation and New Rule

Group	Current Situation (%)	New Rule (%)
Complete Sample	2.37	-1.17
Male	0.29	-3.46
Female	4.63	1.69
Age (AB)	5.20	-1.06
Male	2.07	-3.06
Female	8.14	1.71
Length of Contribution (LCB)	0.06	-1.43
Male	-0.98	-4.65
Female	1.35	1.66

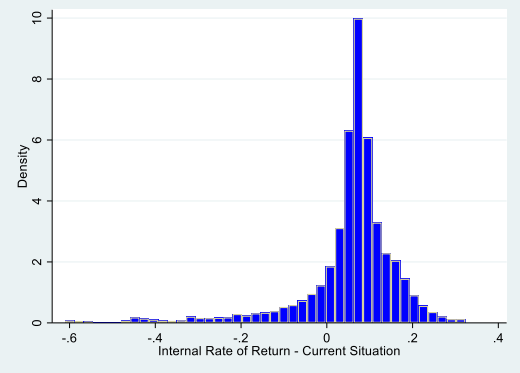
Graph 13 – Internal Rate of Return (*IRR*)
Current Situation



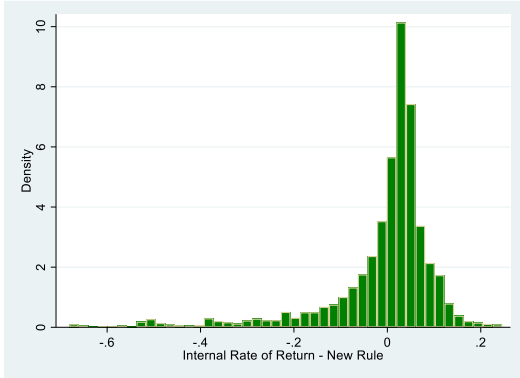
Graph 14 – Internal Rate of Return (*IRR*)
LCB – Current Situation



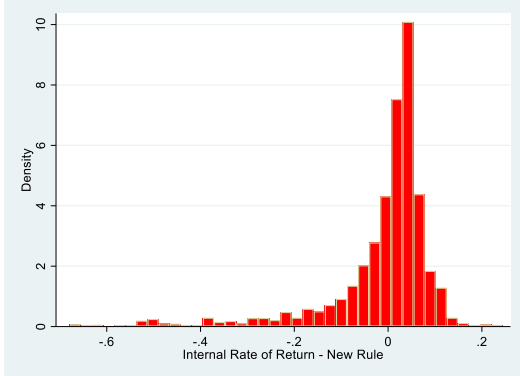
Graph 15 – Internal Rate of Return (*IRR*)
AB – Current Situation



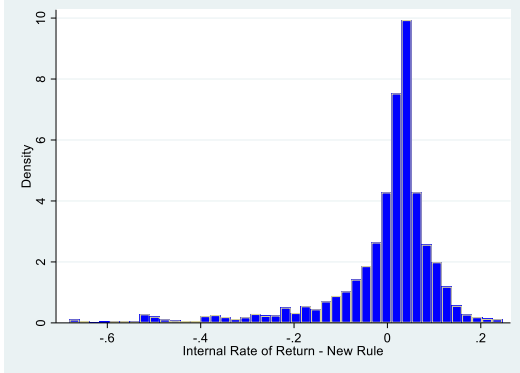
Graph 16 – Internal Rate of Return (*IRR*)
New Rule



Graph 17 – Internal Rate of Return (*IRR*)
LCB – New Rule



Graph 18 – Internal Rate of Return (*IRR*)
AB – New Rule



4.2.4. Average Retirement Duration (*AveDur*)

The last indicator is the Average Retirement Duration (*AveDur*). The calculation is quite simple and is made by the difference between the year the retiree dies and the year the retirement was granted. It works as complementary data to the previous indicators, especially *ReqRate* and *IRR*, and aims to verify if the rules for granting retirement benefits allow for (given the contribution periods weighted by the contribution densities) adequate periods of retirement receipt.

Table 6 results indicate once more large disparities in the Current Rule, between men and women and by type of benefit. It should be noted that there is a joint effect in the same direction to increase the receipt period for women in relation to men, due to both their precocious retirement and higher life expectancy. In the New Rule, all the amounts are lower (effect of the minimum age

imposed on everyone), but differences will still prevail (from the differential of expectancy favoring women). Note that the largest differences are verified for the *LCB*s.

Table 6 – Average Retirement Duration (*AveDur*) by gender and type of old-age benefit Current Situation and New Rule

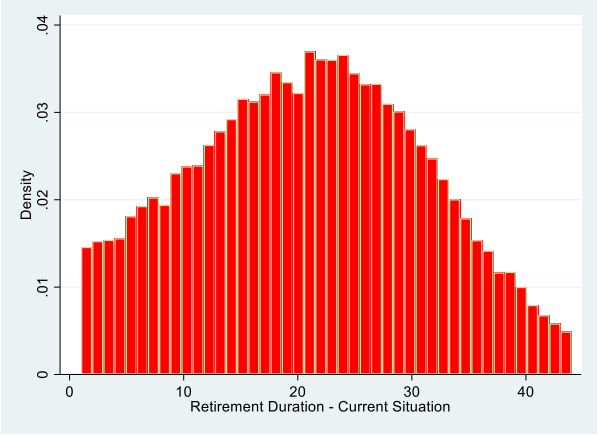
Group	Current Situation (%)	New Rule (%)
Complete Sample	19.45	16.46
Male	17.22	14.91
Female	22.49	18.59
Age (AB)	17.66	16.08
Male	15.25	14.74
Female	20.53	18.08
Length of Contribution (LCB)	20.94	17.40
Male	18.71	15.39
Female	24.49	19.69

Next, Graphs 19 to 24 are shown. These histograms illustrate the fact that the *AveDur* averages do not have all the desired informational power. This is the only indicator that shows a reduction in all the analyzed categories. Moreover, the dispersion of the results is also the lowest of all the indicators. This occurs because in the New Rule, no worker will retire earlier than in the Current Situation. Women are more affected than men. Of these women, the group most affected will be women retiring by length of contribution because they will have to extend their contribution period for longer. On the other hand, this increase will make this group the only to present an increase in the Replacement Rate, as illustrated in table 3 and graphs 1 to 6.

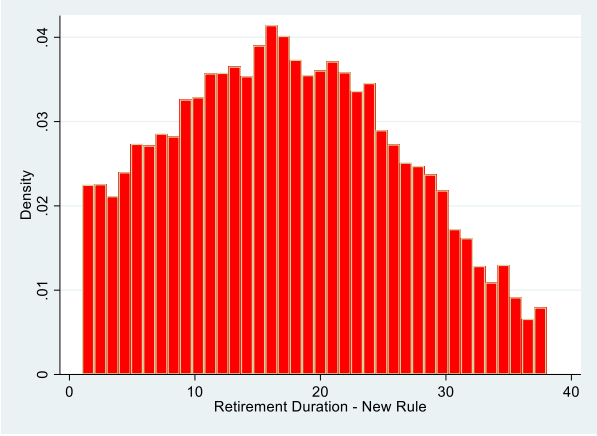
Graph 19 – Average Retirement Duration (*AveDur*) - Current Situation

Graph 22 – Average Retirement Duration (*AveDur*) – New Rule

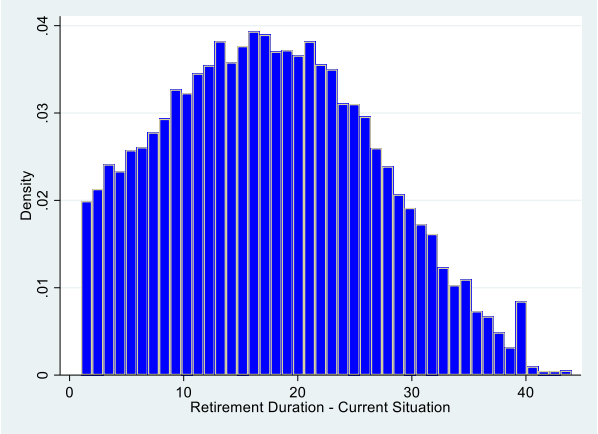
Graph 20 – Average Retirement Duration (*AveDur*) – LCB – Current Situation



Graph 23 – Average Retirement Duration (*AveDur*) – LCB – New Rule



Graph 21 – Average Retirement Duration (*AveDur*) – AB – Current Situation



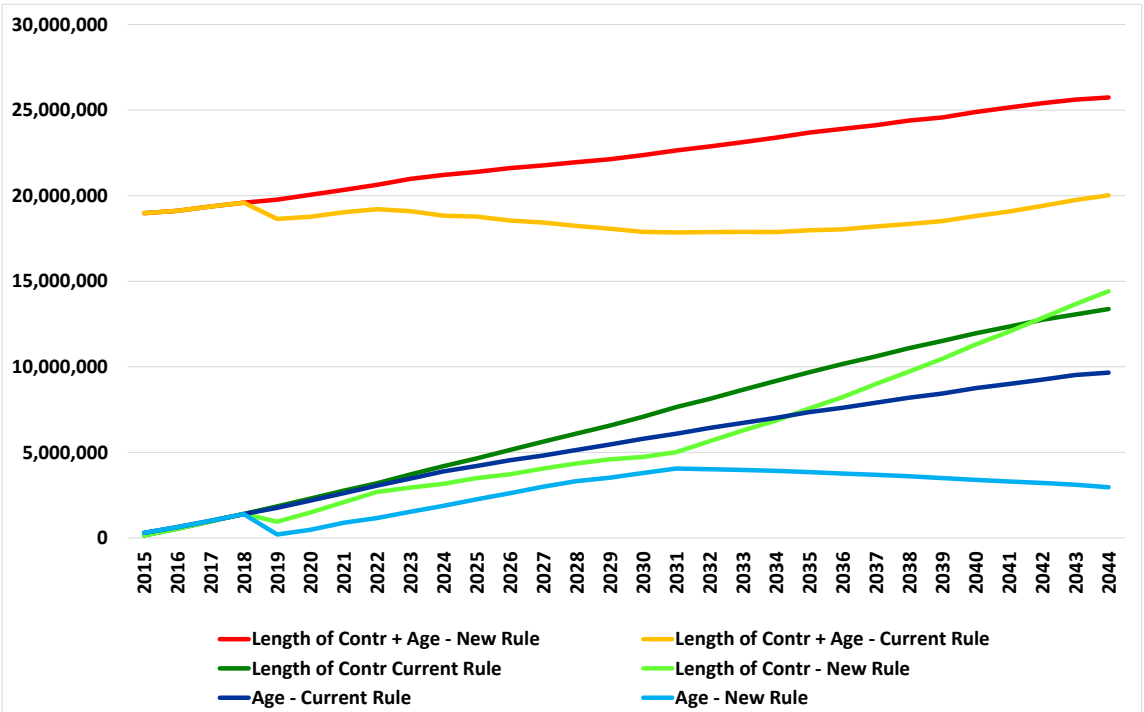
Graph 24 – Average Retirement Duration (*AveDur*) – AB – New Rule

4.3. Aggregate Results

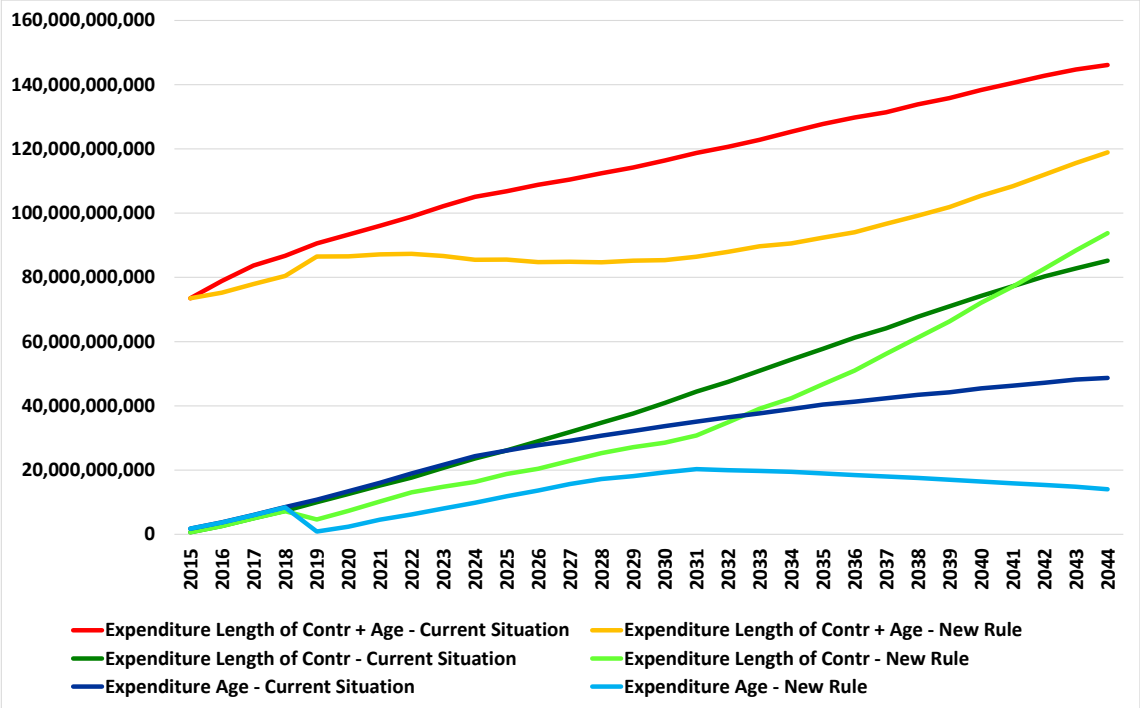
This section contains the aggregate results, i.e., the fiscal impacts of the proposed reform. Graph 25 shows the number of old-age benefits. This represents the stock of paid benefits. Each year, the number of benefits issued is given by the number of the previous year´s benefits added to the benefits granted in that year, from which the ceased benefits are subtracted, whether due to death or loss of eligibility condition. Next, graph 26 shows the annual expenditure on the retirements issued by length of contribution and by age.

Similarly, to what was done for the retirements, graph 27 shows the stock of survivor's benefits and graph 28 the expenditure on these benefits. Graph 29 reports the sum of the aggregate amounts. It also shows the RPGS total expenditure (retirements and pensions), the revenue of workers contributions, and the result (revenue minus expenses every year). In this section, all the monetary values are reported in USD, converted from BRL using the exchange rate of 4.015.

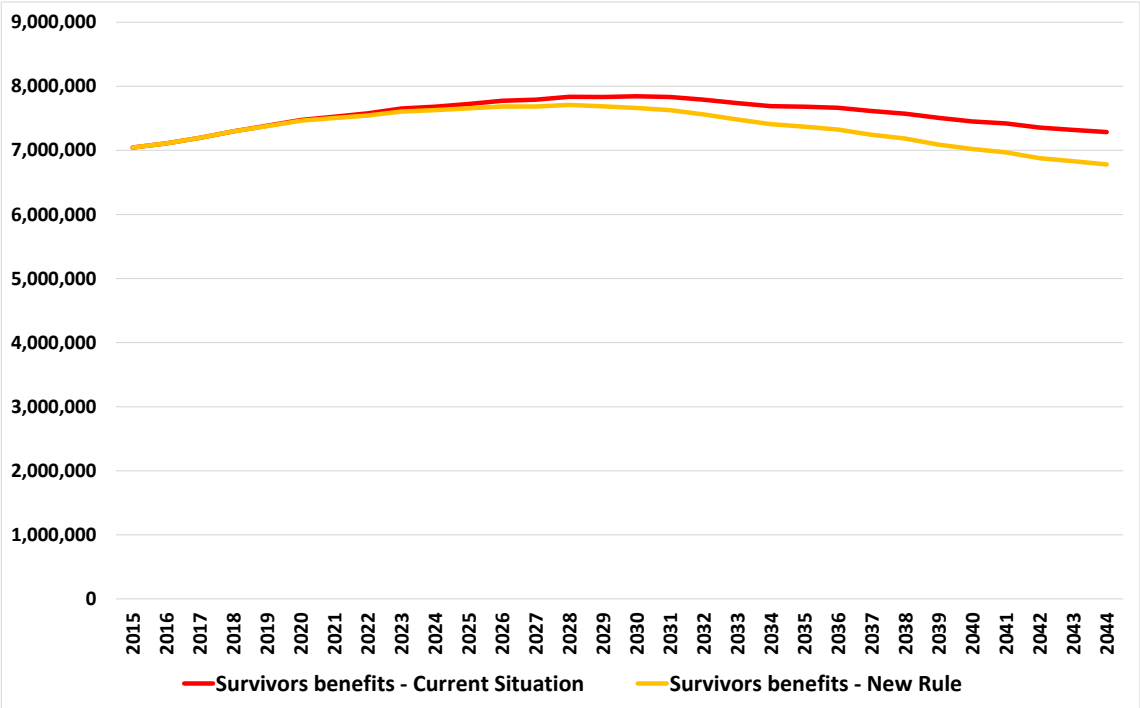
Graph 25 – Number of Old-Age benefits Current Situation and New Rule



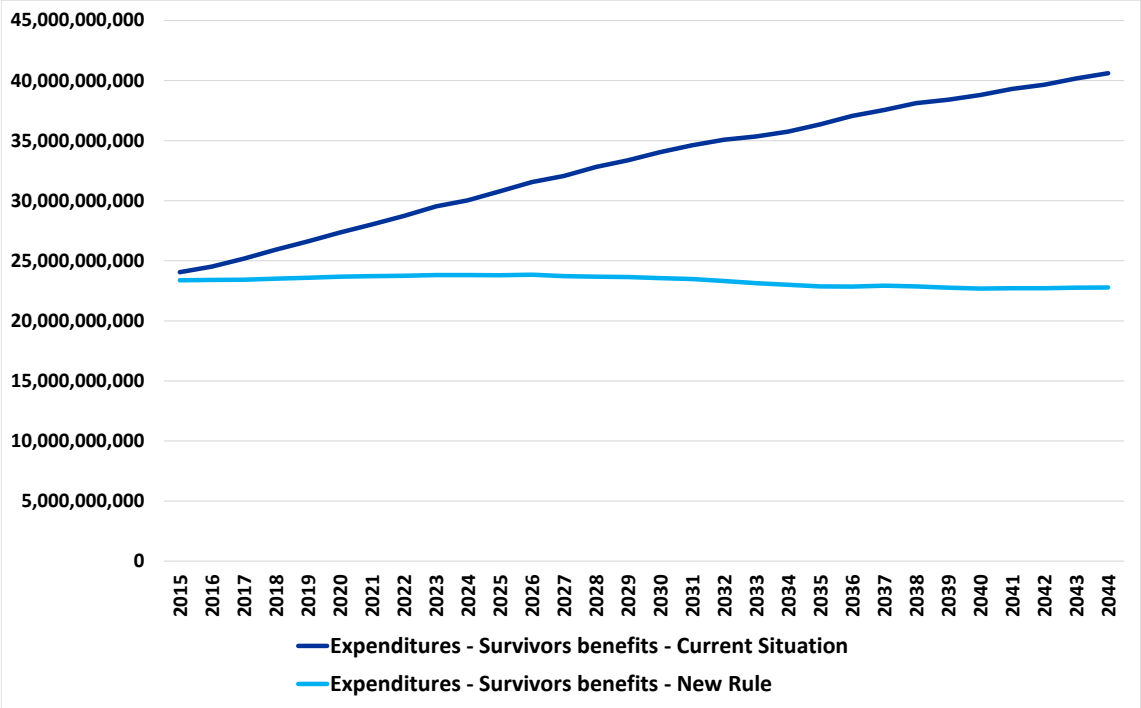
Graph 26 – Expenditure – Old-Age benefits
Current Situation and New Rule
(Amounts in USD)



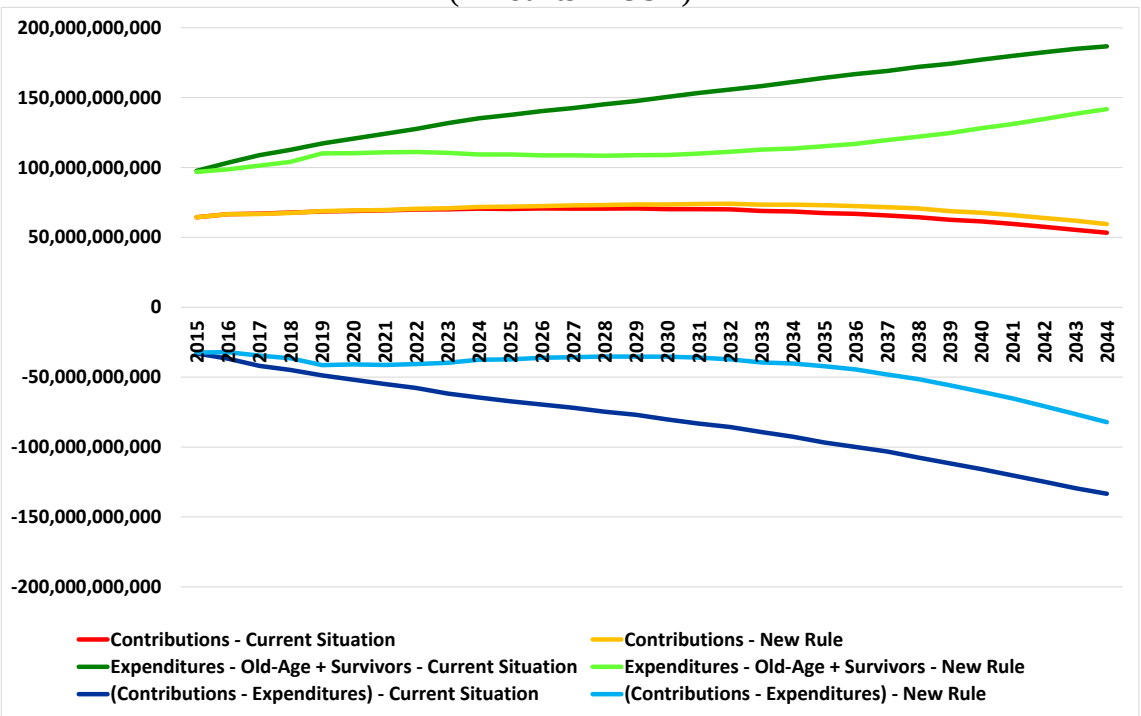
Graph 27 – Number of Survivors benefits
Current Situation and New Rule



Graph 28 – Expenditure - Survivors benefits
Current Situation and New Rule
(Amounts in USD)



Graph 29 – Contributions, Expenditure on Benefits, and Net Result
Current Situation and New Rule
(Amounts in USD)



As shown in graph 29, in the analyzed period the increase in contributions is greatly reduced. In the Current Situation, the contributions sum is around BRL 6.62 trillion (USD 1.65 trillion) and in the New Rule, BRL 6.85 trillion (USD 1.71 trillion) (an increase of 3.51%). This result was already expected given that the higher rates only apply to a small group of workers. The largest gains come, as was planned, from the reduction in expenses. In the Current Situation, the expenditure on retirements and pensions is BRL 13.42 trillion (USD 3.34 trillion). If the rules of the New Rule were

effective, the expense would be of BRL 10.59 trillion (USD 2.64 trillion), configuring a reduction of 21.12%. An important result is the savings from the eventual adoption of the CA. In the first 10 years, the net result would be in the order of BRL 952 billion (USD 237 billion). If we calculate the entire period until 2044, the total savings would be BRL 4.256 trillion (USD 1.06 trillion).

4.4. Pension Liabilities

Next, tables 7 and 8 report the amounts for the Gross (*GPL*) and Net (*NPL)* Pension Liabilities. Both are calculated as described in equations 6 and 7. The amounts are presented for three real discount rates (2%, 3% and 4%) commonly verified in the literature (Billig & Ménard, 2018; Börsch-Supan, 2000; Forteza & Ourens, 2012). The values are reported in BRL and in USD.

Table 7 – Gross Pension Liabilities (*GPL*) - Current Situation and New Rule
(Amounts in BRL trillion and USD trillion)

Discount Rate (% a.a.)	Current Situation (BRL)	New Rule (BRL)	Current Situation (USD)	New Rule (USD)	Δ%
2	13.14	10.36	3.27	2.58	21.16
3	11.44	9.09	2.85	2.26	20.54
4	10.05	8.05	2.50	2.00	19.90

Table 8 – Net Pension Liabilities (*NPL*) - Current Situation and New Rule
(Amounts in BRL trillion and USD trillion)

Discount Rate (% a.a.)	Current Situation (BRL)	New Rule (BRL)	Current Situation (USD)	New Rule (USD)	Δ%
2	6.99	3.95	1.74	0.98	43.49
3	5.99	3.43	1.49	0.85	42.74
4	5.18	3.01	1.29	0.75	41.89

The average reduction in PPB is close to 20%, depending on the discount rate used. For *GPL*, the drop is more significant, just over 42%. This difference occurs because the reform has little effect on the contributions. When the benefits are substantially reduced (around BRL 2.35 trillion, using a discount rate of 3% a.a., equivalent to the 20.54% of the second line of table 6), the difference for the contributions decreases, which explains the highest amounts of the last column to the right of table 7, compared to table 6.

The most relevant indicator is NPL because it represents the present value of all the fiscal deficits verified in the 2015-2044 period. In other words, it is the amount to be borne by the government through other sources of revenue (other than the pension contributions) or by increasing the public indebtedness. The significant reduction obtained for this indicator (42.74% with a discount rate of 3%) shows that the reform proposal achieves its goals when it decreases almost by half the net pension liabilities. However, the amount found indicates that the system is still far from ideal. It should also be emphasized though, that a great part of the imbalance may come from the period of transition, which takes a great part of the 30 years studied.

5. Final Considerations

This study aimed to calculate the impacts of the CA 6/2019, proposed by the government of the President of Brazil, Jair Bolsonaro. For this purpose, we developed a non-behavioral actuarial microsimulation model. The results show that the CA is a step in the right direction to reduce inequalities and the RGPS deficit, although it is not very efficient from a fiscal perspective. The findings show that an important part of the effects will happen with the reduction of the RGPS distributive characteristics, although they occur at the expense of the regime's large deficits, according to what Afonso (2016) has shown. The *RR* will have an average reduction of around seven

percentage points. However, for the *LCB*s there is a small increase, while the *IRR* of the *AB* will sustain a significant drop of over 16 percentage points. That is, those who retire by age will be more greatly impacted by the measure. The Required Rates have become much closer to the current effective rates, with a greater reduction in the retirements by age. For the *IRRs*, the amounts also drop significantly, becoming negative for men. Nonetheless, some intragenerational redistribution by gender is preserved, because the female *IRRs* are higher due to their higher longevity, which becomes more relevant given the postponement of retirements. In the New Rule, old-age benefits are paid for about three years less than what currently occurs, mainly due to the imposition of the minimum age.

The aggregate results show that the RGPS deficit will stay relatively constant over the next 15 years and start increasing from that point on, but at much lower rates than would occur if the reform were not made. In particular, this should occur because the contributive requirements, after the period of transition, are lower, and only the requirement of minimum age is necessary. This result emphasizes that the proper transition formatting is fundamental for the medium-term results of any pension reform. Even so, the reform does not eliminate the deficit but makes it less unsustainable. It would provide better conditions to the government to equate the imbalance in public accounts. Throughout the first 10 years of the reform's implementation, there is an improvement of BRL 952 billion (USD 237 billion) in the net result, a higher amount than the amount initially presented by the government, but in the same order of magnitude.

In general, the conclusions of the study indicate that the measures are correct focusing on the reduction of expenses, which is a key element for the solvency of the public finances. However, part of these gains occurs as a result of the reduction in the RGPS distributive characteristics, due to the standardization of rules. These effects are not promptly or easily perceived and deserve to be studied in detail so that the country is able to properly understand the effects of its public policies.

6. References

Acosta-Ormaechea, S., Espinosa-Vega, M. A., & Wachs, D. (2017). Demographic Changes in Latin America — The Good , the Bad and …. In *IMF Working Paper* (No. 17/94). Retrieved from https://www.imf.org/en/Publications/WP/Issues/2017/04/13/Demographic-Changes-in-Latin-America-The-Good-the-Bad-and-44836

Afonso, L. E. (2016). Progressividade e aspectos distributivos na previdência social: Uma análise com o emprego dos microdados dos registros administrativos do RGPS. *Revista Brasileira de Economia*, *70*(1), 3–30. https://doi.org/10.5935/0034-7140.20160001

Amaglobeli, D., Chai, H., Dabla-norris, E., Dybczak, K., Soto, M., & Tieman, A. F. (2019). The Future of Saving: The Role of Pension System Design in an Aging World. *IMF Staff Discussion Note*, *19/01*, 47. Retrieved from https://www.imf.org/~/media/Files/Publications/SDN/2019/SDN1901.ashx

Barr, N., & Diamond, P. (2006). The Economics of Pensions. *Oxford Review of Economic Policy*, *22*(1), 15–39. https://doi.org/10.1093/oxrep/grj002

Beaumont, J.-F., & Rivest, L.-P. (2009). Dealing with Outliers in Survey Data. In A. S. R. S. Rao & C. R. Rao (Eds.), *Handbook of Statistics* (Vol. 29, pp. 247–279). https://doi.org/10.1016/S0169-7161(08)00011-4

Billig, A., & Ménard, J.-C. (2018). Measuring and reporting the actuarial obligations of the Canada Pension Plan. *International Social Security Review*, *71*(3), 49–71. https://doi.org/10.1111/issr.12178

Bloom, D. E., & McKinnon, R. (2010). Social security and the challenge of demographic change. *International Social Security Review*, *63*(3–4), 3–21. https://doi.org/10.1111/j.1468-246X.2010.01368.x

Börsch-Supan, A. (2000). Incentive effects of social security on labor force participation: evidence in Germany and across Europe. *Journal of Public Economics*, *78*(1–2), 25–49. https://doi.org/10.1016/S0047-2727(99)00110-3

Chybalski, F. (2016). The Multidimensional Efficiency of Pension System: Definition and

Measurement in Cross-Country Studies. *Social Indicators Research*, *128*(1), 15–34. https://doi.org/10.1007/s11205-015-1017-3
Clingman, M., Burkhalter, K., & Chaplain, C. (2019). *Internal real rates of return under the OASDI program for hypothetical workers* (No. 5). Retrieved from https://www.ssa.gov/OACT/NOTES/ran5/an2018-5.pdf
Coleman, D. (2006). Europe's Demographic Future: Determinants, Dimensions, and Challenges. *Population and Development Review*, *32*(S1), 52–95. https://doi.org/10.1111/j.1728-4457.2006.tb00003.x
Damon, J. (2016). *The socio-economic impact of social security*. Retrieved from https://www.issa.int/en_GB/resources/all-publications?p_p_id=displayfoldercontent_WAR_ISSA_Event_Documentsportlet_INSTANCE_EkBtOHHQ3c7r&p_p_lifecycle=2&p_p_state=normal&p_p_mode=view&p_p_cacheability=cacheLevelPage&p_p_col_id=column-1&p_p_col_pos=1&p_p_co
Díaz-Gimenez, J., & Díaz-Saavedra, J. (2017). The future of Spanish pensions. *Journal of Pension Economics and Finance*, *16*(02), 233–265. https://doi.org/10.1017/S1474747216000093
Feldstein, M. (1974). Social Security, Induced Retirement, and Aggregate Capital Accumulation. *The Journal of Political Economy*, *82*(5), 905–926. Retrieved from http://www.jstor.org/stable/1829174
Forteza, A., & Ourens, G. (2012). Redistribution, insurance and incentives to work in Latin-American pension programs. *Journal of Pension Economics and Finance*, *11*(03), 337–364. https://doi.org/10.1017/S1474747211000564
Giambiagi, F., & Afonso, L. E. (2009). Cálculo da alíquota de contribuição previdenciária atuarialmente equilibrada: uma aplicação ao caso brasileiro. *Revista Brasileira de Economia*, *63*(2), 153–179. https://doi.org/10.1590/S0034-71402009000200006
Giambiagi, F., & Afonso, L. E. (2015). Previdência do setor público e INSS: a fotografia e o filme. In P. Tafner, C. Botelho, & R. Erbisti (Eds.), *Reforma da Previdência – a visita da velha senhora*, pp. 107–132. Brasília: Editora Gestão Pública.
International Social Security Association (ISSA). (2015). *Retirement Benefit Provision: Measuring multivariable adequacy and the implications for social security institutions*. Retrieved from http://pensionreform.ru/files/102618/Adequacy retirement report.pdf
Kaufmann, F.-X., & Leisering, L. (1984). Demographic changes as a problem for social security systems. *International Social Security Review*, *37*(4), 388–409. https://doi.org/10.1111/j.1468-246X.1984.tb00839.x
Knell, M. (2009). How automatic adjustment factors affect the internal rate of return of PAYG pension systems. *Journal of Pension Economics and Finance*, *9*(01), 1. https://doi.org/10.1017/S1474747209990035
Leimer, D. R. (1995). A Guide to Social Security Money's Worth Issue. *Social Security Bulletin*, *58*(2), 3–20. Retrieved from http://heinonlinebackup.com/hol-cgi-bin/get_pdf.cgi?handle=hein.journals/ssbul58&section=21
Lüthen, H. (2016). Rates of Return and Early Retirement Disincentives: Evidence from a German Pension Reform. *German Economic Review*, *17*(2), 206–233. https://doi.org/10.1111/geer.12070
Mitchell, O. S., Poterba, J. M., & Warshawsky, M. J. (1999). New Evidence on the Money's Worth of Individual Annuities. *American Economic Review*, *89*(5), 1299–1319. https://doi.org/10.1257/aer.89.5.1299
Morrill, M. S., & Westall, J. (2019). Social security and retirement timing: evidence from a national sample of teachers. *Journal of Pension Economics and Finance*, *In press*, 1–16. https://doi.org/10.1017/S1474747218000422
OECD. (2013). *Pensions at a Glance 2013: OECD and G20 indicators* (1ª). https://doi.org/10.1787/pension_glance-2013-en
OECD. (2015). *Pensions at a Glance 2015: OECD and G20 indicators*. https://doi.org/10.1787/pension_glance-2015-en

Palacios, R., & Pallares-Miralles, M. (2000). International Patterns of Pension Provision. In *Social Protection Discussion Paper Series* (No. 0009). Retrieved from http://siteresources.worldbank.org/SOCIALPROTECTION/Resources/SP-Discussion-papers/Pensions-DP/0009.pdf

Pallares-Miralles, M., Romero, C., & Whitehouse, E. (2012). International Patterns of Pension Provision II: A Worldwide Overview of Facts and Figures. In *Social Protection & Labor Discussion Paper* (No. 1211). Retrieved from http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2012/06/21/000333038_20120621024626/Rendered/PDF/703190NWP0SPL000Box370035B00PUBLIC0.pdf

Penafieri, A. C., & Afonso, L. E. (2013). O impacto da mudança da regra de cálculo das aposentadorias por tempo de contribuição do INSS: o fator previdenciário é atuarialmente justo? *Economia Aplicada*, *17*(4), 667–694. https://doi.org/10.1590/S1413-80502013000400007

Prammer, D. (2018). How does population ageing impact on personal income taxes and social security contributions? *The Journal of the Economics of Ageing*, *In press*, 1–18. https://doi.org/10.1016/j.jeoa.2018.12.005

Rocha, R. de R., & Caetano, M. A.-R. (2008). O sistema previdenciário brasileiro: uma avaliação de desempenho comparada. In *Texto para Discussão - IPEA* (No. 1331). Retrieved from http://www.ipea.gov.br/portal/images/stories/PDFs/TDs/td_1331.pdf

Schwarz, A. M., Arias, O. S., Zviniene, A., Rudolph, H. P., Eckardt, S., Koettl, J., … Abels, M. (2014). *The Inverting Pyramid: Pension Systems Facing Demographic Challenges in Europe and Central Asia* (1st ed.). https://doi.org/10.1596/978-0-8213-9908-8

Symeonidis, G. (2016). The Greek Pension Reform Strategy: 2010-2015. In *Social Protection & Labor Discussion Paper* (No. 1601). Retrieved from http://documents.worldbank.org/curated/en/2016/05/26395359/greek-pension-reform-strategy-20102015

Whitehouse, E., Bogomolova, T., Dorfman, M., Hinz, R., Pallares-Miralles, M., Robalino, D., & Romero-Robayo, C. (2000). *Pension indicators: reliable statistics to improve pension policymaking*. Retrieved from http://documents.worldbank.org/curated/pt/114161468330910597/pdf/703470BRI0P10900036B00PUBLIC00NC010.pdf