Who loses and who wins with the PEC 287/2016? An analysis of the pension wealth variation for the urban beneficiary of Brazilian Social Security System

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This study calculates the impact of the changes in the individual pension wealth due to the proposed constitutional amendment 287/2016 that provides on the retirement eligibility age, benefit replacement rate, benefit accrual formula, and reduced percentage of family benefits. It uses the expected cash flow in actuarial net present value for the contributions and benefits of voluntary retirement, disability retirement, and death pension, in addition to family benefits. The results show that the most affected, are those of almost full retirement age with little contribution time. However, surprisingly, for groups with a high contribution period (more than 29 years for men and 21 for women) and aged between 45 and 55 years for men and between 40 and 54 for women there is an actuarial wealth gain.

Keywords: social security; pension reform; transitional rules; actuarial wealth; actuarial neutrality.

Quem perde e quem ganha com a PEC 287/2016? Uma análise pela variação da riqueza atuarial do segurado urbano brasileiro do Regime Geral de Previdência Social

Este estudo mensura a alteração de riqueza do segurado pela reforma da Proposta de Emenda à Constituição n. 287/2016 (PEC 287, 2016), com a criação do pedágio e alterações na idade mínima, fatores de reposição, média dos salários de contribuição e percentual de reversão das pensões. Propõe-se o uso do indicador valor presente líquido atuarial aplicado ao fluxo de caixa esperado das contribuições e benefícios de aposentadoria programada, por invalidez e pensão por morte, além da reversão a cônjuge com continuidade a filhos menores. Os mais atingidos negativamente são aqueles com idade próxima à aposentadoria por idade e pouco tempo de contribuição. Porém, para grupos com grande tempo de contribuição (mais de 29 anos para homens e 21 para mulheres) e idades entre 45 e 55 anos, para homens, e entre 40 e 54 anos, para mulheres, há um surpreendente ganho de riqueza atuarial.

Palavras-chave: previdência social; reforma previdenciária; regras de transição; riqueza atuarial; neutralidade atuarial.

¿Quién pierde y quién gana con la PEC 287/2016? Un análisis por la variación de la riqueza actuarial del beneficiario urbano del Sistema Brasileño de Seguridad Social

Este estudio mensura la alteración de riqueza del asegurado por la reforma de la Propuesta de Enmienda a la Constitución (PEC) 287/2016, con la creación del peaje fiscal y alteraciones en el tiempo mínimo de contribución, factores de reposición, media de las contribuciones y porcentual de reversión de las pensiones. Se propone uso del indicador valor presente neto actuarial aplicado al flujo de caja esperado de las contribuciones y beneficios de jubilación programada, por invalidez y pensión por muerte, además de la reversión al cónyuge con continuidad a hijos menores. Los más afectados negativamente son aquellos con edad próxima a la jubilación por edad y poco tiempo de contribución. Sin embargo, para grupos con gran tiempo de contribución (más de 29 años para hombres y de 21 para mujeres) y edades entre 45 y 55 años para hombres y entre 40 y 54 para mujeres hay un sorprendente beneficio de riqueza actuarial.

Palabras clave: previsión social; reforma previsional; regla de transición; riqueza actuarial; neutralidad actuarial.

1. INTRODUCTION

The rules regarding funding (revenues) and benefits (expenses) for social security have generated an environment of uncertainty and conflicts between agents of Brazilian society since the Federal Constitution (CF, 1988), and especially since the mid-1990s when the financial deficits of the Brazilian Social Security System (RGPS) were initiated. Since then, the main reforms and counter-reforms have occurred with the Constitutional Amendments 20/1998, 41/2003, 47/2005 and 70/2012, in addition to the specific legislation – particularly the law providing for the social security welfare factor and the law "85-95" (aimed at reducing the benefits growth rate). The Proposal for Amendment to the Constitution (PEC) 287/2016 (PEC 287, 2016) aims to converge the rules referring to the different social security regimes in place, even though such convergence does not structurally solve the deficit.

With each constitutional reform, there is always a juridical discussion about the social contract involving the acquired rights and the expectation of rights. Thus, one question of great discussion is the characteristic of the transition rules, popularly known as "toll," which are created by the legislator in an attempt to soften the breach of the expectation of rights. According to the Brazilian Institute of Actuary (IBA), the toll should be continuously verified, avoiding abrupt discontinuity, particularly regarding the age issue. The ideal would be to guarantee all the acquired rights, respecting the rights accumulated in proportion to the time of contribution under the previous rules and the future time in the new rules (*Instituto Brasileiro de Atuária* [IBA], 2017). Thus, the benefit should not be affected discontinuously beyond the eligibility conditions.

However, the Brazilian legal system does not offer any protection regarding the expectation of rights, as there is no obligation to offer a transition rule. Also due to the complexity of the subject, there is no single solution for the proportional preservation of rights acquired by the previous rules of the RGPS. Another factor that poses difficulties to the system's sustainability is that the RGPS, managed by the National Social Security Institute (INSS), was structured under the pay-as-you-go system, in which there are no individual savings account or social security fund, and the regime has to consider the tax perspective weighted by the income distribution function and welfare state policy.

Given the social and economic relevance of the Brazilian social security system, mainly because it comprises the majority of the country's population, this article analyzes the proposal for a change in the system's regime for the urban workers. The analysis adopts the concepts of actuarial neutrality (Queisser & Whitehouse, 2006) and actuarial wealth (Meneu, Devesa, Devesa, Domínguez, & Encinas, 2016; Reinsdorf, 2010). The objective is to ascertain from the individual point of view whether there is the preservation of the expectation of rights. Also, the study investigates whether there are significant discontinuities in the treatment currently offered to different profiles of beneficiaries, brought by the transition rules of the reform proposal.

Few studies cover all the aspects contemplated in the benefits offered by social security as the analysis of retirement based on age or contribution period is prioritized because they represent the more significant part of the social security expenditures. As observed by Penafieri and Afonso (2013), there is a gap in the Brazilian literature, which does not approach the long-term risk benefits (disability pension and death pension). Consequently, the studies have not observed all the family wealth offered by the social security regime (considering the disability or death of the insured, the

latter implying in the possibility of reversion to the spouse or partner, as well as to minor children). In this article, all the long-term benefits offered by social security were projected, which is an innovation in the Brazilian academic production.

The study considered the wealth variation as the actuarial wealth measured by the net actuarial present value of the cash flow stream of the insured and their family, together, as calculated in the study by Rodrigues and Afonso (2015) and Freire and Afonso (2015). However, we extended to three lives because of the measurement of the pension that contemplates reversion to a minor. The use of the net present value indicator, instead of the internal rate of return, for example, is justified because it is the only one that allows measuring wealth variations in monetary units, despite the disadvantage in raising the discussion about the definition of the threshold fixed for the discount rate assumption.

Some studies based on the current rules analyze the variation caused when an insured chooses a) to anticipate the retirement considering the contribution period (calculated with the social security welfare factor); or b) to postpone it to enable the use of a higher welfare factor, or using the factor '1' if they match the rule "85-95" (Penafieri & Afonso, 2013; Zanella, Carvalho, & Afonso, 2014). This study is not the only academic attempt of evaluating the reform proposed in Brazil by the government of President Temer. Research such as the work by Afonso and H. Zylberstajn (2017) and Ferreira (2018) also studied the Constitution Amendment PEC 287 (2016), but adopted different indicators and approaches, and did not take a closer look at the benefits paid by disability and death, which are always more frequent after raising the minimum age for the planned retirement benefits. It should be pointed out that this study does not aim to compare the Brazilian case with other countries. For this matter, we recommend the international research carried out by organizations such as the Organization for Economic Cooperation and Development (OCDE) (Organisation for Economic Co-Operation and Development [OECD], 2011, 2013, 2015), the World Bank (Pallares-Miralles, Romero, & Whitehouse, 2012), and the International Labor Organization (International Labour Organization [ILO], 2017) (the latter is focused on labor issues, reducing inequalities, and protecting low-income populations).

Clark, Smeeding, Burkhauser, Quinn, and Moon (2004) used similar factors as those proposed in this research and identified four ways of comparing wealth transfer in social security systems: transfer between higher and lower incomes; men and women; single and married; and past and future generations. Mazzaferro, Morcicano, and Savegnago (2012) included in the debate the issue of the insured person's education, which has a high and well-known correlation with income. This article compared the changes in wealth based on an actuarial approach through representative individuals. The study innovates by detailing two dimensions: the combination of different age profiles and contribution periods. This innovation is an outcome of the analysis of how the insured are affected regarding their different ages and the period they have contributed to the system, as well as the analysis of the dimensions 'income' and 'gender' which are traditionally used.

Against this backdrop, some questions that are naturally asked from all over society are:

- Which insured profiles will be most affected by the entry into force of the proposed pension reform?
- Is there similar treatment regarding the effects of the transition rule on the insured's family wealth?
- Will the pension reform harm the entire the insured population?

This article addresses these issues and advances on aspects of measurement and improvement of the transition rule. The results suggest the proposal of more balanced rules by the government. We, therefore, seek to contribute to the debate on pension reform and to bring relevant information to the society.

2. LITERATURE REVIEW

The social security system is a complex institution performing several roles simultaneously (Quinn, 1999). Some aspects resemble a long-term savings program, which represents the primary purpose of complementary pension plans, usually designed so that pricing reflects the actuarial fairness that, according to Queisser and Whitehouse (2006), is defined by the benefits throughout the life of the insured. Numerically, actuarial fairness is established by the equality between the net present value of social security contributions and benefits, both in the past and in the future. In Brazil, because supplementary pension plans are optional and the current offers are limited to contribution plans in the form of capitalization of individual savings accounts, the actuarial fairness is a mandatory contractual clause (considering that this model does not have the mutualism present in the old private plans that offered a previously established benefit).

The social security system also has features of products such as insurance, since it offers coverage in case of disability (disability pension) or death (death pension to the spouse and children) of an insured. It is also an essential program of family income redistribution since its structure of progressivity transfers income from high-income participants to those with low income. In this context, actuarial fairness is not always favored and, consequently, the concept of actuarial neutrality takes more space. For details of the design of Brazilian social security system and a comparison with BRIC countries, and others of the North and Latin America, as well as Germany, Italy, Portugal, and Sweden, see Matijascic (2016).

The first significant study that detailed the concept of actuarial neutrality and actuarial fairness was that of Queisser and Whitehouse (2006). For the authors, neutrality involves a marginal economic concept related to the effect of working for additional time, such as a few months or years, and therefore is also called marginal actuarial fairness by some authors, such as Belloni and Maccheroni (2013). As for D'Addio, Keese, and Whitehouse (2010), if the pension system does not penalize or reward early retirement, then it is actuarially neutral in its impact on work incentives. The authors show that for most of the countries studied, members of the Organization for Economic Co-operation and Development (OECD), there is a trend between recent social security reforms regarding the reduction of neutrality. The reforms are encouraging more than the actuarially proportional to the postponement of retirement from 60 to 65 years, which can be seen as an attempt to reduce the frequency of early retirements. Against this trend would be only the countries of the Czech Republic and Korea for those with average wages or Ireland and Slovakia for lower wages.

It is important to recognize that for the mandatory social security system, it may be interesting to count on simple and uniform rules treating insured people of different profiles in the same way, and this aspect can be a powerful instrument of the income distribution. Curiously, Gragnolati,

Jorgensen, Rocha and Fruttero (2011) have identified that the government does not always exercise the distributive function intentionally, although changes in rules tend to have this purpose. This reinforces the importance of studying the rules regarding the system's funding and benefits, observing the concepts of actuarial fairness and, especially, actuarial neutrality.

The current global demographic and economic issues together with aspects related to the labor market have produced imbalances between revenues and expenditure of social security systems in several countries, which motivated parametric or structural funding reforms, the latter observed by H. Zylberstajn, E. Zylberstajn, Afonso e Souza (2010) for the Brazilian case. Parametric reforms try not to break with the funding regime, with the rules of funding and benefits in force, changing only the parameters of the same structure. Pallares-Miralles et al. (2012) show that the main parametric changes refer to the eligibility conditions, contribution rates and incidence, benefit accrual formula and its adjustment, period of payment, establishment of the benefits for minimum and maximum amounts.

The Brazilian reform proposed in 2016-2018, as well as the changes started in the 1990s referred to the qualifying conditions (minimum age and contribution period) and in the formula for calculating benefits (accrual formula). In addition, the changes only applied to future benefits, since Brazilian consolidated jurisprudence that there is an acquired right for the benefits already granted, which may change only for monetary restatement. In a way, the notion of 'acquired right' for social security – which is debatable in several countries – ends up rewarding the previous generations who were precisely those who fail to update the rules on funding and benefits or do not carry out the gradual parametric reforms that would ensure the system's sustainability.

The Constitution Amendment (PEC) 287/2016 providing for the pension reform sent by the executive branch to the parliament at the end of 2016 has been modified over the past months and changes are under discussion until the present day, marked by the last months of President Temer's mandate (end of 2018). To understand the difficulties to approve the reform, it is essential to keep in mind that this type of legislation requires a two-way vote and approval of at least 3/5 of the members of the two houses of the legislative, The Chamber of Deputies and the Senate. This article shows the three main versions of the reform proposal, which was not yet approved at the time of its publication. The details about the evolution of the proposed parametric changes for the RGPS urban pensions are summarized (in appendix).

Social security reforms are usually motivated by the fiscal factor, and aspects related to the progressivity in income are always present. Considering this characteristic, we group the main recent national studies from a fiscal and distributive point of view, as well as from the point of view of the insured, used in this study. The studies are separated based on the conclusions we understand as the most interesting within this classification, which is subject to overlapping.

2.1 Fiscal point of view

In this group of studies, the factors that affect the fiscal sustainability of the RGPS are highlighted, such as those of Leite, Ness and Klotzle (2010) for the period 1995-2006; Matos, Melo and Simonassi (2013) for 1990-2010; Miller and Castanheira (2013) for 2005-2050; and Lima

and Matias-Pereira (2014) for 2003-2030. These studies use explanatory factors such as fertility and mortality rate, the real growth of contributions, the dependency ratio (number of insured per taxpayer), informal work, unemployment rate, and minimum wage value. They all conclude that the system is not sustainable, except for Matos et al. (2013) who conclude that the deficit performance of the RGPS could have characterized insolvency only between April 1994 and October 1997. However, Lima, Wilbert, Pereira and Paulo (2012) agree with the majority of the authors and show that, even with the implementation of the social security welfare factor in the late 1990s, the slowdown in expenditure growth did not lead to structural equilibrium. For the authors, the factor affects only the pensions based on contribution period, which represent one-third of the total amount. This conclusion corroborates the arguments by Delgado, Querino, Rangel e Stivali (2006), who said that the social security welfare factor had led to a large reduction in the average amount of the affected pensions, especially in the case of women. The authors say, however, that it did not provoke an increase in the average age of retirement, emphasizing that it was the Constitutional Amendment (EC 20, 1998),, which was truly responsible for the significant increase of the average ages.

These studies point to demographic factors as responsible for the current growing deficits, such as the increasing dependency ratio among the elderly and the population aging rate, resulted in large part from the drop in fertility and mortality rates. The conclusion when analyzing these studies is that the insolvency of the RGPS is not explained only by endogenous factors such as benevolence in the rules of access to benefits or low contribution rates. The main explanation is the funding regime, which is strongly dependent on exogenous aspects such as demographic dynamics, economic growth, employment level, and degree of formality of the labor market.

2.2 Distributive point of view

A group of studies evaluates the progressivity (reduction of inequalities) or regressivity in the income distribution by the Gini Index decomposition. They usually work based on data from the National Household Sample Survey (PNAD), the Continuous PNAD (Caetano et al., 2016; Medeiros & Souza, 2014; Rangel & Saboia, 2015), or the Family Development Index, which, according to Reis, Silveira, Braga and Costa (2015), minimizes deficiencies in the Human Development Index.

The main conclusions are that the state has influenced progressively in the RGPS, which is desirable but is influencing with regressivity in the social security special system for public servants (RPPS) at the federal level (Medeiros & Souza, 2014). According to Rangel and Saboia (2015), even after 2013, with the limitation of the value of the social security tax (INSS) ceiling for the public servants insured by the federal RPPS (because of the creation of the Funpresp pension fund), there would be no major impacts on (regressive) income distribution despite the reduction in public spending in the long term. Recently, Caetano et al. (2016) concluded that, with the possibility of the end of the social security welfare factor, there would be a decrease in the RGPS progressivity, i.e., it has the function of reducing inequalities mainly because it only influences contributory pensions, whose beneficiaries have higher income.

Other studies carry out factual or counterfactual exercises based on indicators such as qualifying conditions, replacement ratio, internal rate of return and the (actuarial balance) rate required, applied to the PNAD data (Afonso & H. Zylberstajn, 2017; Ferreira, 2018; Marri, Wajnman, & Andrade, 2011) or individual data of the people insured by the RGPS (Afonso, 2016). According to current rules of the RGPS, Afonso (2016) observes the evidence of progressivity due to the better indicators obtained for women, less educated, lower income individuals, and for age pensions. However, with the amendments proposed by the PEC 287/2016, Afonso and H. Zylberstajn (2017) conclude that the original version of the reform (the one presented by the executive branch at the end of 2016), improves the actuarial fairness of the system and worsens the distributive progressivity of income. They explain that the most significant disadvantages are for women, because of the loss of anticipation of five years in retirement, and the lower income insured population since the retirement by age in that version of the reform would have the grace increased from 15 to 25 years. Subsequently, the bill went through modifications from December 2016 to December 2017. Ferreira (2018) analyzed the modified version using the PNAD data and projecting the insured persons who would be retired over a 30-years horizon. She compared the data considering the rules in force and the rules provided in the two versions of the PEC 287 (2016). The author segregated the insured by income, occupation, region, ethnicity, and education, analyzing who would be able to retire and who could no longer retire with the changes. The conclusion was that women and the population in the rural areas would be the ones to lose more benefits in the original proposal presented by the executive branch at the end of 2016. As for the version modified in the Congress and debated at the end of 2017, the lost observed before for the rural population was remedied. Regarding the decrease in the amount of the initial monthly income (replacement), the first version would produce more considerable losses mainly in the population with income ranging from one to five minimum wages. However, the study did not analyze the new changes that would occur at the beginning of 2018, when the legislative branch reestablished the grace from 25 to 15 years.

2.3 Point of view of the insured

Among the studies that emphasize the insured's point of view, we highlight the pioneering work by Giambiagi and Afonso (2009), who calculated the actuarially balanced contribution rate, which equals the expected present value of contributions and pensions of RGPS, for differences in gender and educational level. They concluded that rates of 31% (employee 11% plus employer 20%) are excessive for retirement based on contribution period, but benevolent for retirement by age, especially for women with longer life expectancy. Previously (in 2007), the government had already reduced the individual (liberal professional) taxpayer's rate from 20% to 11% in the case of retiring at the minimum wage (usually retirement age). Based on this measure, Foguel, Moreira, and Santos (2012) concluded that this change reduced the level of informality, reaching a relative increase of 9% (men) or 5% (women) in the probability of voluntary contributions.

Penafieri and Afonso (2013) analyzed the possibility of the insured to postpone retirement based on the contribution period using the social security welfare factor, choosing the new full

retirement adopting the rule "85-95". Using the indicators replacement ratio, internal rate of return, and actuarial balance rate, they concluded that the welfare factor penalizes early retirements more than the actuarial neutrality, that is, it reduces the benefit value more than necessary by the marginal actuarial balance between contributions and benefits. However, according to Caetano et al. (2016), even with this advantageous incentive for the lack of actuarial neutrality of the social security welfare factor, in general, the worker chooses not to postpone their retirement in exchange for a higher replacement ratio.

Zanella et al. (2014) also emphasize the insured's decision-making. They calculated the optimal periods for the insured in the RGPS to come out of retirement (which would be declared unconstitutional by the Federal Supreme Court on October 26, 2016). Based on the incentive represented by the gradual improvement of the social security welfare factor applied to the average of the wage contribution, the authors used the indicators replacement ratio, internal rate of return, and effective and required rate to find that the internal rate of return would be maximized on average at four years and 10 months after retirement (men) or 7 years and 10 months (women).

Rodrigues and Afonso (2015) adopted the replacement ratio indicator using actuarial annuities with multiple lives to calculate the total benefit (original retirement, special benefit, and supplementary retirement) in the scenarios before and after the change with the implementation of Funpresp. The authors found that the voluntary participation for the public servant who started working in government before February 2013 is unfavorable for all genders, ages, and income levels, as there would be a 17% reduction in the value of retirement for men and 15% for women. Only very unlikely conditions, with a real rate of return on assets of more than 9.4% per annum, would mean that these benefits would not be reduced.

These studies corroborate, directly or indirectly, the importance in establishing the rate of return assumption or the discount interest rate. Although not a study emphasizing the insured point of view but the fiscal one, Caldart, Motta, Caetano, and Bonatto (2014), when analyzing the robustness of the actuarial result of the RPPS in the state of Rio Grande do Sul, concluded that the interest rate is more relevant than other assumptions. The authors empirically observed the importance based on the sensitivity of the results, first to the interest rate, wage growth rate and actuarial table (survival and death probabilities). As for a more-in-depth theoretical study, Benelli, Siviero, and Costa (2016) offer a broad bibliographic review and detailed theoretical explanations about the various actuarial assumptions and their impacts on the insured and the institution. In the previous year, the issue was discussed in public consultation with actuary professionals, with subsequent normatization by the Actuarial Pronouncements Committee 003 of the Brazilian Actuarial Institute (IBA, 2016) to act in private pension entities. The consultation involved, biometric assumptions (actuarial tables of survival, mortality, disability, and morbidity), demographic (family composition, rules of retirement and turnover/replacement), economic (inflation, wage growth and benefits) and financial (real interest rate). In 2017 and 2018, the Ministry of Social Security opened a public consultation and created working groups to propose amendments to the norms that deal, among other things, with the parameters chosen for the assumptions and hypothesis of the actuarial evaluations of the RPPS, states, federal district, and municipalities. Regarding the RGPS, there are no specific norms to address these benchmarks, perhaps because the financial regime adopted is

pay-as-you-go, although there are annual long-term actuarial projections made and published in the Budget Guidelines Law.

3. METHODOLOGY

Professionals and academics involved in social security often use terms such as financial and actuarial balance, solidarity and mutualism. These concepts are applied to the Brazilian context of social security by the perspective of the system as a whole, but from the point of view of the insurer and not of the insured, as explained by Nogueira (2012). The point of view when analyzing the system may offer conflicting objectives between the concepts of actuarial neutrality and actuarial fairness detailed by Queisser and Whitehouse (2006). In addition, the insured's individual perspective has particularities that will be discussed in detail.

In order to quantify actuarial neutrality, only the net present value of the future cash flow from the insured's point of view is calculated, since we are interested in the future variations analyzed here by a new social security rule that does not retroact. Thus, we calculate the gain or loss of actuarial wealth in the situation of working longer due to the change of rules. By the value of money in time, postponing retirement reduces the wealth, in addition to the fact that it will be received for less time. However, if the benefit is postponed there is an incentive to increase the replacement (initial amount of the benefit), in some cases, the second effect may surpass the first. If the incentive is made in a way that does not generate increase or decrease of wealth, the effects cancel out, and the new regime will be of actuarial neutrality. However, social security reforms around the world almost always aim at reducing the insured's wealth in order to become a sustainable social security system.

The changes in the rules proposed in the PEC 287 (2016) are summarized in box 1. If on the one hand, they increase the contribution time and the minimum age for the planned retirement, on the other they usually change the amount of the benefit for less (in some cases, curiously, for more). To verify some of the cases in which there is a gain in the replacement ratio see columns "social security welfare factor - current rule" and "replacement ratio – new rule" in tables 3 and 4 of the section 'results and discussion'. These show the comparison of the new percentages of replacement ratio applied to the average of all wage contribution with those of the calculation of the welfare factor or the rule "85-95" applied to the average of 80% higher salaries.

From this scenario of changes, we calculated the combined effect of the change in the initial date and initial amount of the benefit in wealth, identifying those most affected. The transition rule is made with the objective of no abrupt changes mainly in the rules of benefits for the insured who are in the imminence of acquiring the right to the planned retirement. Therefore, it is important to evaluate whether actuarial neutrality occurs mainly for the group that is close to retiring, and whether there is homogeneity for the negative changes in actuarial wealth in the other insured profiles.

BOX 1   **MAIN CHANGES PROPOSED BY PEC 287/2016 (VERSION OF JANUARY 2018)**

- 30% toll on the contribution period remaining to reach 35 years (men) or 30 years (women) at the time of passing the reform, for the retirement based on contribution period;
- Creation of minimum ages to retire based on contribution period: 55 years old (men) or 53 years old (women), with a one-year increase every two years after passing the reform, reaching 65 years old (men) or 62 years old (women);
- Increase of the minimum age for retirement based on age (only women): from 60 to 61 years old after two years of passing the reform, and for 62 years old, after four years of the reform. Note: For men, the minimum age to retire remains at 65 years old;
- For retirement based on the contribution period, the social security welfare factor and the rule "85-95" (optional) are extinct. For retirement based on age, end of the social security welfare factor (optional) and of the replacement percentages of 85% + 1.0% for each year that exceeds 15 years of contribution, limited to 100% (at 30 years);
- Creation of new replacement percentages for any future retirement: 60% + 1.0% for each year that exceeds 15 years of contribution, + 1.5% from 26 years, + 2% from 31 years and + 2.5% from 36 years, limited to 100% (at 40 years of contribution);
- Benefit salary: change from the average of the 80% highest contributions to the average of all contributions paid;
- Reduction of the survivor benefits from 100% to 50% + 10% for each insured (spouse or dependents) without quote reversion, limited to 100%.

Source: Elaborated by the authors.

3.1 Representative individuals and adopted assumptions

The cash flow and present actuarial value were based on the non-behavioral micro-simulations model for representative individuals, with different characteristics of gender, age and contribution period, in addition to the wage contribution (a proxy for income profile). Calculations were made for thousands of INSS profiles of insured people who have not yet met the requirements for planned retirement and are subject to the transition rule. The contribution period varied from 15 years (grace of 180 contributions). The age varied from 45 years for men or from 40 years for women, because at these ages the individuals will be 65 or 62 years old, respectively, when the transitional period for minimum age will be equivalent to the definitive rule. In this way, there is a broad understanding of the impact of the changes in the benefit rules to be granted if the legislation of PEC 287/2016 passes. Box 2 shows the profiles of the insured and the actuarial assumptions used for the projections on the base date of the change of the rules with the approval of the reform.

The assumptions related to family composition, percentage of insured with spouse or partner and their age, as well as the number of minors and the age of the youngest child, were chosen according to the standard generally used and the characteristics closest to the insured population (an example of study on the variation of the assumptions regarding family composition is the work by Freire and Afonso, 2015). According to national studies, the real discount rate was set at 3% per year and the real wage growth rate was defined as 2% per year, in line with Giambiagi and Afonso (2009); Afonso and Lima (2011); Penafieri and Afonso (2013); Caldart et al. (2014); Rodrigues and Afonso (2015); Afonso (2016). It should be noted that wage growth of 2% was set only for the middle-income profile, because

as it is a study of the transition rule applied to the employee who is at the end of their working life, it was considered that the profile of low income equal to the minimum wage will continue with this salary level (zero salary growth), while for the profile of people with wages above the INSS ceiling, positive wage growth is irrelevant for purposes of changing the value of the employee's contribution precisely because there is this upper limit.

BOX 2 — REPRESENTATIVE INDIVIDUALS AND ASSUMPTIONS ADOPTED TO PROJECT THE CASH FLOW (BASE ON JANUARY 2018)

- Age/gender of the insured: variable from 40 to 65 (men) and from 40 to 60 years (women).
- Contribution period: variable from 15 to 35 years (men) and from 15 to 30 years (women).
- Wage contribution on the date of the reform: R$2,185.00 – profile of middle-income according to PNAD (rate of 9%); minimum wage R$965.00 – profile of low-income (rate of 8%); INSS ceiling R$5,645.81 – profile of high-income (11% rate of contribution).
- Contribution rates: 8%, 9% or 11% according to provisions established by Ordinance from the Ministry of Finance.
- Real wage growth rate: 2% per year (middle-income); null (low-income); not applicable (high-income).
- Density of future contributions: 100% (no interruptions during the contribution period).
- Percentage of insured with spouse or partner: 100%.
- Age of spouse or partner: four years difference between men and women.
- Age of the youngest child: was born when the mother was 35 years old.
- Age where children are considered adults for the purpose of survivor benefit: 21 years.
- Percentage of the benefit paid to survivors: 100% (before the reform) or 70% (after the reform).
- Actuarial table of survival/mortality of non-disabled person: IBGE 2016 (IBGE, 2017) by gender, put in months by exponential interpolation, and extrapolated by the Blended method (Hustead, 2005:3) by exponential regression from 80 to 115 years with data from the last 20 years of probabilities.
- Actuarial table of survival/mortality of disabled person: Experience IAPC.
- Actuarial table for disability entry: Álvaro Vindas.
  Available at: <www.atuarios.org.br/tabuas-biometricas>
- Real interest rate (discount): 3% per annum (insured opportunity cost).

Source: Elaborated by the authors.

It is important to make observations regarding some international studies presented here, such as the work by Queisser and Whitehouse (2006). The authors suggest that the rate of wage growth should be defined as the one used for the discount rate. In our point of view, this suggestion is not compatible with the Brazilian context, due to the high-interest rates in the country. There is no consensus on the international literature, and recent studies by the Organization for Economic Cooperation and Development have set the rate of wage growth at 1.25% (OECD, 2015), whereas previously it was 2% (OECD 2013, 2011), while the discount rate has always been maintained at 2%. In the last OECD study, the rate of wage growth for the member countries ranged from 0.94% to 2.47% and the discount rate, between 1.08% and 2.75% (OECD, 2015).

3.2 Wealth indicator

Feldstein (1974) defines the gross social security wealth as the present value of the retirement benefits that could be required by everyone who is working or already retired. The net social security wealth, however, is defined as the gross social security wealth less the present value of taxes and social security contributions to be paid by those who work.

Börsch-Supan (2000) uses the concept of net social security wealth at the individual level and calculates the incentives that lead the insured to postpone their retirement. Reinsdorf (2010) and OECD (2015) also use the individual level of wealth and call it net pension wealth, considering the possibility of a social security contribution or any tax paid by the insured already receiving benefits.

For the indicator of the actuarial wealth of the individuals observed in this study, the present value of the cash flow of the social security balance of each month of the insured was used. Therefore, the present value of the benefits less the social security contributions was calculated, which was further decomposed by the benefits of planned retirement (based on age or contribution period), disability retirement and survivor benefits, according to the model explained in detail in this section.

According to Meneu et al. (2016), actuarial wealth is constructed from the present actuarial value, discounted from an interest rate, from a series of future payments made and received. The actuarial nature is characterized by the fact that each cash flow is multiplied by the probability of payments made or received estimated by the actuarial tables.

Therefore, the cash flow was calculated according to the annuities of the traditional deterministic actuarial mathematics, i.e., using the statistical concept of expected value of a random variable with known probability distribution (Bowers, Gerber, Hickman, Jones, & Nesbitt, 1997; Pitacco, 2014). As for the national studies, Afonso and Lima (2011) detail in equations (1) to (9) the annuity involving a single life and under only a transition of the insured status into the probability ("healthy" – "dead"). Rodrigues and Afonso (2015) use the model of two lives, while Freire and Afonso (2015) use the three-lives model, which is the one adopted here, (insured aged x, spouse of age y, and minor under age z_0). Thus, we considered in the calculations the measurement of the family coverage to the dependent youngest minor (age z_0), who will be entitled to any pension to be paid until reaching the age of z_1=21 years old, according to the assumptions shown in box 2.

Because the study also measures the long-term risk benefits, it is necessary to include the transition to the "disabled" status in order to calculate the expected value for disability retirement. This means that, on the matrix of transition probabilities of the Markov chain applied to the status of "healthy", "disabled" and "dead" beneficiary, the Hamza method was used, described in detail by Pitacco (2014), which is widely used for pension plans that provide for multiple contingencies, in this case only two, 'disability' and 'death'.

In the model, equations (1) and (2), show that the planned retirement has an actuarial present value α, being paid B monetary units to the beneficiary of age x, after the temporary deferment t, also considering in case of death, the pension reversible in $(100 \cdot \rho)$% to the spouse or partner of age y, with continuity to minors, the youngest aged z_0, paid until reaching the age of z_1 years old. The annual allowance represented by "(13)" refers to a 13th salary, appropriate 1/12 to each month during the year, and v^t represents the financial discount factor, which is equivalent to $(1+i)^{-t}$, i is the interest rate and t the deferment period, that is, the remaining period for the entry into the planned retirement. It

was considered that the beneficiary chooses the type of retirement (based on age or on contribution period) that leads to enjoying the right in less time, according to the predominant behavior identified by Caetano et al. (2016), besides the fact that the insured usually does not prepare a cash flow to guide optimal decision-making about a possible postponement.

$$\alpha = v^t \cdot {}_t p_x^{aa} \cdot B_{x+t} \cdot H_{x+t} \tag{1}$$

$$H_{x+t} = 13 \cdot \left[{}_{z_1-z_0-t/} a_{x+t}^{(13)} + (1-\rho) \cdot a_{x+t:\overline{z_1-z_0-t}|}^{(13)} + \rho \cdot \left(a_{\overline{z_1-z_0-t}|}^{(13)} + {}_{z_1-z_0-t/} a_{y+t}^{(13)} - {}_{z_1-z_0-t/} a_{x+t\ y+t}^{(13)} \right) \right] \tag{2}$$

The equations (3) and (4) calculate the disability pension, which has actuarial present value β, being paid to the insured, also including the survivor benefit to the spouse or partner, continuity to the children (temporary coverage), only started during the period of contribution.

$$\beta = \sum_{k=1}^{t} {}_{k-1} p_x^{aa} \cdot p_{x+k-1}^{ai} \cdot v^{k-1/2} \cdot B_{x+k-1/2} \cdot H_{x+k-1/2}^{i(13)} \tag{3}$$

$$\text{onde } H_{x+k-1/2}^{i(13)} = 13 \cdot \left[{}_{z_1-z_0-k+1/2/} a_{x+k-1/2}^{i(13)} + (1-\rho) \cdot a_{x+k-1/2:\overline{z_1-z_0-k+1/2}|}^{i(13)} + ...\right.$$

$$\left. ...+ \rho \cdot \left(a_{\overline{z_1-z_0-k+1/2}|}^{(13)} + {}_{z_1-z_0-k+1/2/} a_{y+k-1/2}^{(13)} - {}_{z_1-z_0-k+1/2/} a_{x+k-1/2\ y+k-1/2}^{(13)}{}_i \right) \right] \tag{4}$$

Equations (5) and (6) included the survivors' benefits, which have an actuarial present value γ, being paid to the spouse or partner in case of death of the insured, including continuity to the children, temporary coverage, only started during the period of contribution.

$$\gamma = \sum_{k=1}^{t} {}_{k-1} p_x^{aa} \cdot q_{x+k-1}^{aa} \cdot v^{k-1/2} \cdot B_{x+k-1/2} \cdot H_{y+k-1/2} \tag{5}$$

$$H_{y+k-1/2} = \rho \cdot \left(a_{\overline{z_1-z_0-k+1/2}|}^{(13)} + {}_{z_1-z_0-k+1/2/} a_{y+k-1/2}^{(13)} \right) \tag{6}$$

According to equation (7), the contributions of the insured represent a negative cash flow and have an actuarial present value π, paid at the contribution rate C_{x+k} applied to the wage contribution S_{x+k}, provided that no benefit is initiated for pension or in death.

$$\pi = \sum_{k=1}^{t} v^k \cdot {}_k p_x^{aa} \cdot c_{x+k} \cdot S_{x+k} \tag{7}$$

From this construction, the wealth change caused by the transition rule was calculated as follows: for each insured profile, future actuarial wealth was calculated at net present value, defined by the sum of equations (1), (3) and (5), subtracted from (7). The variation Δ in actuarial wealth (ΔAW), for the pre- and post-retirement moments, is defined in (8) by monetary units, and the results are discussed in absolute and percentage changes.

$$\Delta AW = \Delta(\alpha + \beta + \gamma - \pi) \tag{8}$$

The actuarial wealth (AW), calculated in this study for the representative individuals, corresponds to the net present value calculated for each beneficiary, and is directly equivalent to the value of the mathematical provision of benefits to be granted when the values for all the taxpayers aggregated by each plan of the social security (open or closed) entities or the special regimes are summed. If calculated for the insured that are already retired, it corresponds to the value of the mathematical provision of benefits granted. In funded plans under the capitalization financial regime, the sum of these provisions is compared (subtracted) to the plan assets in order to determine the result of the surplus or actuarial deficit. In public unfunded systems under pay-as-you-go system, such as the RGPS, there are no assets or pension funds, so the sum of these provisions is equivalent to what is called an actuarial liability, or according to the international literature, pension debt (ILO, 2017). For a recent discussion on accounting for these provisions, see Reis, Lima, and Wilbert (2017).

4. RESULTS AND DISCUSSION

The variation (gain or loss) in actuarial wealth was calculated for each representative individual (combination of age, contribution period, gender and income). As the transition rules of pension reforms are generally not defined from the principles of actuarial neutrality, there may be significant differences between pre and post-retirement wealth variations. By compulsory application of the toll, the insured under the transition rule will be subject to a longer period of work and contribution, until the scheduled retirement. On the other hand, the change in the rules of the replacement ratio may favor some groups with the increase of the initial value of the benefit. This is due to the revocation of the social security welfare factor and the "85-95" rule applied to the average of the 80% higher wage contribution, replaced by the new replacement ratio that varies from 60% to 100%, with annual increments of 1% 1.5%, 2% or 2.5%, applied to the average of all salaries, according to rules summarized in table 1.

From this, in order to measure and understand the combined effect of these changes, the variations pre and post-reform were calculated for men and women insured, with wage contribution equivalent to the minimum wage of R$965.00 (INSS floor), R$2,185.00 and R$5,645.81 (INSS ceiling), respectively representing low, medium and high incomes. The construction of the representative individuals aimed to focus the detailed analysis of the combination of the factors of age and contribution calculated in a practically continuous time, since the monthly variation of the ages from 40 to 65 years old (men) or 40 to 60 (incomplete) years old (women), while the contribution period at the time of retirement varied from 15 to 35 years (men) or from 15 to 30 years (women). The calculated range was sufficient to cover all the most advantageous possibilities of using the transition rule when compared to the definitive rule of the minimum age of 65 years (men) and 62 years (women).

It is important to emphasize that the study assumes that the insured person chooses the type of retirement, (based on age or the contribution period), that leads to retire earlier, according to the predominant behavior observed by Caetano et al. (2016). This means, for example, that an insured man of 55 years old that has contributed for 25 years would retire based on the contribution period at 65 years of age and 35 years contribution, applying the rule "85-95" (factor 100%) to establish the accrued benefit as the average of the 80% highest wage contributions, and not the social security welfare factor. However, as the transition rule imposes a toll for a further three years of contribution (30% over the remaining ten years), after retirement a man insured is given the option of anticipating retirement by the age retirement rule at age 65 with a replacement factor of 87.5% to the average of all contribution wages, and no longer 68 years for the contribution period, although with a greater replacement factor of 95%.

The calculations showed that the different combinations of age and contribution period reveal a widely dispersed treatment of wealth variation. Contrary to what is expected, to be a reform that causes loss of actuarial wealth for all insured, there have been some cases of wealth gain, going against the fiscal objective. Situations of different wealth variations were expected due to the fact that the lawmaker did not use the principles of actuarial neutrality to support the parameters of the retirement transition rule. However, the variations are so diverse that there were gains in certain cases, which turned out to be a surprise.

As detailed in tables 1 (men) and 2 (women), the profile of favored insured or wealth earners with a middle-income is the one with long contribution period (more than 29 years for men and 21 years for women) and ages between 45 and 55 years old for men and between 40 and 54 years old for women. In general, women obtained greater gains than men due to the revocation of the social security welfare factor, considering that they retire before men and that the factor penalizes more than the actuarial neutrality, as corroborated by Penafieri and Afonso (2013). We also find an interesting phenomenon in which the relative gain (percentage) of wealth in points of median ages equal to 50 years old (men) or 45 years old (women) is maximized, shown by shaded lines in the tables.

TABLE 1   **PROFILES OF INSURED MIDDLE-INCOME MEN WITH WEALTH GAIN, BASED ON THE PARAMETRIC CHANGES PROPOSED BY THE PEC 287/2016 IN THE TIME TO RETIRE AND IN THE REPLACEMENT RATIO OF THE PLANNED RETIREMENT AND PENSION**

AGE AND CONTRIBUTION PERIOD (YEARS)		TIME REMAINING TO RETIRE CURRENT RULE (YEARS)	TIME REMAINING TO RETIRE TRANSITIONAL RULE (YEARS)	WELFARE FACTOR CURRENT RULE	REPLACEMENT FACTOR NEW RULE	ACTUARIAL WEALTH BEFORE REFORM (R$ THOUSAND)	ACTUARIAL WEALTH AFTER REFORM (R$ THOUSAND)	GAIN OF ACTUARIAL WEALTH (%)
45	29	6.0	13.0	0.595	1.000	398	418	5.0
46	29	6.0	12.0	0.616	1.000	404	425	5.1
46	30	5.0	12.0	0.595	1.000	400	421	5.2

Continue

AGE AND CONTRIBUTION PERIOD (YEARS)		TIME REMAINING TO RETIRE CURRENT RULE (YEARS)	TIME REMAINING TO RETIRE TRANSITIONAL RULE (YEARS)	WELFARE FACTOR CURRENT RULE	REPLACEMENT FACTOR NEW RULE	ACTUARIAL WEALTH BEFORE REFORM (R$ THOUSAND)	ACTUARIAL WEALTH AFTER REFORM (R$ THOUSAND)	GAIN OF ACTUARIAL WEALTH (%)
47	29	6.0	11.0	0.639	1.000	410	431	5.3
47	30	5.0	11.0	0.616	1.000	406	428	5.4
47	31	4.0	10.0	0.595	1.000	403	443	10.0
48	29	6.0	10.0	0.662	0.975	416	428	3.0
48	30	5.0	10.0	0.639	1.000	412	435	5.6
48	31	4.0	9.0	0.616	1.000	409	451	10.3
48	32	3.0	8.0	0.595	1.000	405	467	15.1
49	30	5.0	9.0	0.662	0.975	418	432	3.4
49	31	4.0	8.0	0.639	0.975	415	448	8.0
49	32	3.0	7.0	0.616	0.975	411	464	12.8
49	33	2.0	7.0	0.595	1.000	408	471	15.6
50	30	5.0	8.0	0.687	0.950	424	429	1.2
50	31	4.0	7.0	0.662	0.950	421	445	5.8
50	32	3.0	6.0	0.639	0.950	417	461	10.5
50	33	2.0	6.0	0.616	0.975	414	469	13.3
50	34	1.0	5.0	0.595	0.975	410	485	18.3
51	31	4.0	6.0	0.687	0.925	427	442	3.5
51	32	3.0	5.0	0.662	0.925	423	458	8.2
51	33	2.0	5.0	0.639	0.950	420	466	11.0
51	34	1.0	4.0	0.616	0.950	416	482	15.9
52	32	3.0	4.0	0.687	0.900	429	454	5.8
52	33	2.0	4.0	0.662	0.925	426	463	8.7
52	34	1.0	3.0	0.639	0.925	422	479	13.6
53	33	2.0	3.0	0.687	0.900	432	459	6.4
53	34	1.0	2.0	0.662	0.900	428	476	11.2
54	34	1.0	1.3	0.687	0.875	435	467	7.5
55	34	1.0	1.3	0.713	0.875	441	456	3.4

Source: Elaborated by the authors.

Note: The social security welfare factor (current rule) is applied to the accrued benefit, which corresponds to the average of the 80% higher wage contributions, or approximately 77% of the last wage (wage growth of 2% per year for 35 years). The replacement factor (new rule) is applied to the accrued benefit, which corresponds to the average of all the wage contributions, that is, between 67% and 72% of the last wage.

TABLE 2 PROFILES OF INSURED MIDDLE-INCOME WOMEN WITH WEALTH GAIN, BASED ON THE PARAMETRIC CHANGES PROPOSED BY THE PEC IN 287/2016 IN THE TIME TO RETIRE AND IN THE REPLACEMENT RATIO OF THE PLANNED RETIREMENT AND PENSION

AGE AND CONTRIBUTION PERIOD (YEARS)		TIME REMAINING TO RETIRE CURRENT RULE (YEARS)	TIME REMAINING TO RETIRE TRANSITIONAL RULE (YEARS)	WELFARE FACTOR CURRENT RULE	REPLACEMENT FACTOR NEW RULE	ACTUARIAL WEALTH BEFORE REFORM (R$ THOUSAND)	ACTUARIAL WEALTH AFTER REFORM (R$ THOUSAND)	GAIN OF ACTUARIAL WEALTH (%)
40	21	9.0	18.0	0.556	0.975	345	362	4.8
40	22	8.0	18.0	0.538	1.000	345	368	6.8
40	23	7.0	17.0	0.520	1.000	344	384	11.4
40	24	6.0	16.0	0.504	1.000	346	400	15.4
41	21	9.0	17.0	0.575	0.950	350	360	2.8
41	22	8.0	17.0	0.556	0.975	349	366	4.8
41	23	7.0	16.0	0.538	0.975	349	381	9.4
41	24	6.0	15.0	0.520	0.975	348	397	14.0
41	25	5.0	15.0	0.504	1.000	348	404	16.1
42	22	8.0	16.0	0.575	0.950	354	364	2.8
42	23	7.0	15.0	0.556	0.950	353	379	7.3
42	24	6.0	14.0	0.538	0.950	353	395	11.9
42	25	5.0	14.0	0.520	0.975	352	402	14.0
42	26	4.0	13.0	0.504	0.975	352	418	18.7
43	23	7.0	14.0	0.575	0.925	358	377	5.3
43	24	6.0	13.0	0.556	0.925	357	392	9.8
43	25	5.0	13.0	0.538	0.950	357	400	11.9
43	26	4.0	12.0	0.520	0.950	357	416	16.6
43	27	3.0	11.0	0.504	0.950	356	432	21.3
44	23	7.0	13.0	0.595	0.900	362	374	3.3
44	24	6.0	12.0	0.575	0.900	362	390	7.7
44	25	5.0	12.0	0.556	0.925	362	397	9.9
44	26	4.0	11.0	0.538	0.925	361	414	14.5
44	27	3.0	10.0	0.520	0.925	361	430	19.1
44	28	2.0	10.0	0.504	0.950	361	438	21.4
45	23	7.0	12.0	0.616	0.875	367	372	1.3
45	24	6.0	11.0	0.595	0.875	367	387	5.6
45	25	5.0	11.0	0.575	0.900	366	395	7.8
45	26	4.0	10.0	0.556	0.900	366	411	12.3
45	27	3.0	9.0	0.538	0.900	366	427	16.9
45	28	2.0	9.0	0.520	0.925	365	436	19.2
45	29	1.0	8.0	0.504	0.925	365	453	24.0
46	24	6.0	10.0	0.616	0.855	371	387	4.2

Continue

AGE AND CONTRIBUTION PERIOD (YEARS)		TIME REMAINING TO RETIRE CURRENT RULE (YEARS)	TIME REMAINING TO RETIRE TRANSITIONAL RULE (YEARS)	WELFARE FACTOR CURRENT RULE	REPLACEMENT FACTOR NEW RULE	ACTUARIAL WEALTH BEFORE REFORM (R$ THOUSAND)	ACTUARIAL WEALTH AFTER REFORM (R$ THOUSAND)	GAIN OF ACTUARIAL WEALTH (%)
46	25	5.0	10.0	0.595	0.875	371	392	5.8
46	26	4.0	9.0	0.575	0.875	371	408	10.2
46	27	3.0	8.0	0.556	0.875	370	425	14.7
46	28	2.0	8.0	0.538	0.900	370	433	17.1
46	29	1.0	7.0	0.520	0.900	370	450	21.8
47	24	6.0	9.0	0.639	0.835	376	386	2.7
47	25	5.0	9.0	0.616	0.855	375	392	4.4
47	26	4.0	8.0	0.595	0.855	375	408	8.7
47	27	3.0	7.0	0.575	0.855	375	424	13.2
47	28	2.0	7.0	0.556	0.875	375	430	14.9
47	29	1.0	6.0	0.538	0.875	374	447	19.5
48	24	6.0	8.0	0.662	0.815	380	385	1.3
48	25	5.0	8.0	0.639	0.835	380	391	2.9
48	26	4.0	7.0	0.616	0.835	380	407	7.2
48	27	3.0	6.0	0.595	0.835	379	424	11.6
48	28	2.0	6.0	0.575	0.855	379	430	13.4
48	29	1.0	5.0	0.556	0.855	379	447	17.9
49	25	5.0	7.0	0.662	0.815	385	390	1.5
49	26	4.0	6.0	0.639	0.815	384	406	5.8
49	27	3.0	5.0	0.616	0.815	371	423	13.9
49	28	2.0	5.0	0.595	0.835	384	429	11.8
49	29	1.0	4.0	0.575	0.835	383	446	16.3
50	26	4.0	5.3	0.662	0.795	389	401	3.0
50	27	3.0	4.0	0.639	0.795	389	422	8.5
50	28	2.0	4.0	0.616	0.815	388	428	10.3
50	29	1.0	3.0	0.595	0.815	388	445	14.7
51	27	3.0	3.9	0.662	0.775	393	402	2.2
51	28	2.0	3.0	0.639	0.795	393	428	8.7
51	29	1.0	2.0	0.616	0.795	393	444	13.1
52	28	2.0	2.7	0.662	0.775	398	413	3.7
52	29	1.0	1.3	0.639	0.775	398	437	10.0
53	29	1.0	1.3	0.662	0.775	402	427	6.1
54	29	1.0	1.3	0.687	0.775	407	416	2.2

Source: Elaborated by the authors
Note: The social security welfare factor (current rule) is applied to the accrued benefit, which corresponds to the average of the 80% higher wage contributions, or approximately 80% of the last wage (wage growth of 2% per year for 30 years). The replacement factor (new rule) is applied to the accrued benefit, which corresponds to the average of all the wage contributions, that is, between 69% and 75% of the last wage.

Similar results were obtained for the favored profile of low-income insured persons (more than 29 years of contribution for men and 26 years for women, and age group between 48 and 55 years old for men and between 42 and 54 years old for women), and for the favored profile of high-income insured (more than 31 years of contribution for men and 26 for women and age group between 48 and 55 years for men and between 43 and 54 for women), with maximization of wealth increase at the age of 50 for men, and 51 years old for women. Tables for low and high-income profiles were omitted due to space constraints, but are available upon request.

Among those insured with actuarial wealth gain, it was found that for the same combination of gender, age and contribution period, those most favored, proportionally, are middle-income, followed by low-income, and then the high-income groups. For example, a 50-year-old man with 34 years of contribution and middle-income (R$ 2,185.00) will get a wealth gain of 20.6%. As for the wage contribution based on the INSS floor (low-income) and the INSS ceiling (high-income), gains are 12.4% and 11.4%, respectively. A qualitatively similar phenomenon occurs for women of 45 years of age and 29 years of contribution, whose gains are 24% (middle-income), 11.8% (low-income) and 9.9% (high-income). This is because those who receive a minimum wage contribute the minimum rate of 8%. The insured who receive above the INSS ceiling will get slightly less gains because they have to contribute in the additional toll period with a rate higher than 11%. The group with middle-income studied obtained the highest gains, because although they contribute with a median rate of 9%, we worked with the assumption of a wage growth of 2% per year, which substantially increases the initial value of replacement ration of the retirement benefit even with the change in the form of the calculation of the average previously fixed on the 80% greater contributions (expurgating the 20% lower) and, after retirement, on all contributions.

Looking at the negative changes on wealth normally expected after pension reforms, the profile of those with wealth loss due to the change were insured women with a middle-income, due to the change in the way the average wage contribution is calculated (same explanation given to the group who gained); age close to retirement based on age, and who started the period of contribution after 30 years of age, i.e., they would not meet the eligibility requirements for contributory retirement age. For the group using the retirement based on age, wealth losses of up to 37.3% (men) or up to 41.2% (women) were calculated. The main explanatory factor stems from the large decrease in the percentage of replacement from 85% to 60% at 15 years of contribution, or from 86% to 61% at 16 years, and so on, as detailed in table 1. The situation is aggravated for women because, in addition to the decrease in the value of the benefit, the minimum age for eligibility for retirement based on age is raised from 60 to 61 years old after two years of passing the reform and to 62 years old after four years of passing the reform, while for men it remains unchanged at 65 years old.

5. CONCLUSION

According to our findings, although the transition rule of the PEC 287/2016 (version of January 2018) causes changes that increase the period of contribution, in some cases generating wealth gain for the insured, as it increases more than proportionally the replacement ratio used in the calculation of the initial accrued benefit based on the definition of actuarial neutrality (Queisser & Whitehouse, 2006). However, we conclude with this study that after the "toll payment" of the transition rule, the

insured will likely continue, and still more frequently, retiring shortly after eligibility requirements have been met. This is because the proposed final rule, after fulfilling the transition rule, reduces the incentive to postpone retirement when compared to the social security welfare factor and rule "85-95" analyzed by Penafieri and Afonso (2013). Another reason to reinforce this behavior is that the Brazilian worker as a rule does not choose a higher and possibly more advantageous retirement replacement ratio, as identified by Caetano et al. (2016).

In a phenomenon similar to what happens in most countries studied in international literature (OECD, 2015), the Brazilian reform proposal is less and less aligned to the principle of actuarial neutrality when defining the transition rules of the planned retirement, considering that the toll has a linear factor of 30% regardless of any variable, and the replacement percentages between 60% and 100% depend only on age and no longer on the contribution period and gender, as occurs for the social security welfare factor.

As a result, we observed that the transition rule generates surprising wealth gains for a restricted group of insured with a long contribution period (more than 29 years for men and 21 years for women) and median ages between 45 and 55 years old for men and between 40 and 54 years old for women. Among those who gain, the most favored are the ones with a middle-income, ages close to 50 years old (men) or 45 years old (women), and longer contribution period (at the time of retirement based on contribution period), which obtained a maximum wealth increase of 18.3% (men) or 24% (women). Women in this profile obtained greater gains than men due to the revocation of the social security welfare factor, which penalizes anticipated retirement more than the actuarial neutrality, according to Penafieri and Afonso (2013).

The most affected negatively suffered losses of wealth of up to 37.3% (men) or up to 41.2% (women), revealing the group with high age close to retirement based on age (65 years old for men or 60 years old for women, according to the current rules in force, pre-reform), little contribution period (who joined the RGPS after 30 years of age and therefore insufficient time to retire based on contribution time), and high income, above the INSS ceiling. The explanation stems from a large reduction in replacement ratio, equivalent to 25 percentage points in retirement based on age, and the change in the form of the average calculation (from the average of the 80% of the highest wage contribution to the average of all wage contributions). As for gender, in this profile women were more disadvantaged because the minimum age for eligibility for retirement based on age is raised from 60 to 61 years old after two years of passing the reform and for 62 years old after four years of passing the reform, while for men it remains unchanged for 65 years old.

It should be noted that, because the last version of the PEC 287/2016, prepared in January 2018, preserved the right to the benefit in an amount never less than the minimum wage (which was not contemplated in the original version of December 2016), and also canceled the increase from 15 to 25 years in the minimum contribution period, this disadvantaged group is in a slightly better situation in comparison to the original bill, regardless of the smaller contributions to the system in both period and value of contributions. This reveals the improvement in the distributive progressivity when comparing the first with the second versions, and these with the third version of the reform. This was probably the intention of the government from the outset in accordance with the narrative conveyed, but it may also have been the result of a negotiation attempt to approve the reform, since a natural solution would

be to create a transitional rule by gradually raising the minimum contribution period from 15 to 25 years over the next 20 years, as occurred for minimum age requirements.

Even in the face of these improvements, the conclusions obtained by Afonso and H. Zylberstajn (2017) for the first version of the PEC 287/2016 and by Ferreira (2018) for the first two versions are that there are signs of deterioration in the distributive and actuarial neutrality characteristics when comparing the reform proposals with the current rule. These authors observed evidence of improvement in actuarial fairness, but in our understanding, from the individual point of view, further studies are needed to observe whether the internal rate of return approached opportunity cost for the insured population, even if it decreased, which is beyond the scope of this study. We consider that this is a practical effect that portrays the increase of actuarial fairness, as the numerical equivalence between contributions and benefits in the past and future (Queisser & Whitehouse, 2006), from the standpoint of the individual. Although the reform favors those with greater contribution period, generally with higher incomes, and disadvantages those with less contribution period and lower income, we do not affirm that the reform causes a decrease in the distributive progressiveness of the RGPS, since the cases illustrated do not represent the majority of the insured. For the analysis of the improvement or worsening of the distributive function of the system as a whole, it is necessary to use individualized microdata of the insured, weighting the results.

There are no studies that have calculated and evaluated the particularities found here, from which we conclude that the changes proposed by the version of January 2018 of the PEC 287 (2016) were too benevolent for the group identified as middle-income, long contribution period and near age 50 (men) or 45 (women), that obtained surprising gains of wealth. In addition, the age profile was very much at odds with the first version of the reform proposed at the end of 2016, as it was equal to the minimum age limit to qualify for the transition rule, defined at the time by a 50% toll on the remaining time, and not 30% without minimum age restriction as in the last version. Therefore, it is possible to interpret that the imposition of the minimum age as a qualifying condition according to the transition rules proposed in the first version of the reform was inappropriate. In addition, the first version was not adequate in setting a very low percentage of toll (30% currently) given the replacement factors (from 60% to 100% above the average) or, from the opposite direction, by the high replacement factors, given the toll percentage.

It would be preferable if technical adjustment parameters were used, such as those applied to the social security reform in Sweden, which adopts a mixed model of capitalization and pay-as-you-go system, or in Germany, where the pay-as-you-go system is adopted. However, the proposed change to the Brazilian pay-as-you-go system is based on political negotiations and very few technical inputs, similar to the processes in France and Italy, on which Börsch-Supan (2007) concluded that there is a need for further short term reforms.

The findings presented here show the relevance of a field of study that analyzes and proposes the creation of formulas with technical parameters leading to automatic changes in the rules over time due to demographic and financial aspects (Meneu et al., 2016; Vidal-Meliá, Boado-Penas, & Settergren, 2009). The social security factor is an example of an automatic change that has recently reduced the value of pensions by approximately 0.7% in each year in which the actuarial table elaborated by IBGE is updated. The first version of the PEC 287/2016 included a device of automatic increase in the

minimum age in a year following each increase of one year in the expectation of survival; however, those with lower incomes would be increasingly impaired because of the lower survival rates, as verified by Souza (2018). The biggest challenge, therefore, is the elaboration of dynamic rules that lead to fiscal adjustment and maintain the distributive progressivity, without neglecting the search for actuarial neutrality.

A recent line of studies also seeks to evaluate the effect of the behavior of the insured influencing on the dynamic rules, in addition to the traditionally used neutrality (Mazzaferro et al., 2012; Ventura-Marco & Vidal-Meliá, 2014). This is a limitation of the model used as it did not consider the behavior of the insured in the decisions of retirement postponement (Borella & Moscarola, 2010), since it adopted the idea that the insured retire as soon as they meet the eligible conditions. Another point that was not evaluated is the influence of the taxation of the income tax on the variations of wealth. Brazilian taxation is altered by inflation levels and also affects the regime's distribution, but its rules are more perennial and are usually not modified along with the social security reform environment. We also appreciate that new studies analyze the robustness of the results by developing sensitivity to the main assumptions, such as Caldart et al. (2014), or by performing complex simulations incorporating stochastic components to the variables, so that a probabilistic interpretation is given to results (Cronin et al., 2005).

One suggestion for future work of equal importance and that would not imply changes or adjustments of the model used here, is to replicate it with the use of microdata from the INSS's insured administrative records, such as the study of Delgado et al. (2006) or more recently Afonso (2016), who used the Social Security Information and Technology Company (Dataprev) database of the Ministry of Social Security. This would allow, in addition to calculating the intra and intergenerational distributional aspects, measuring the variation of total pension wealth for the Brazilian insured, a figure that has never been presented, despite it being highly relevant.

We hope that this work on the treatment of wealth gains and losses promotes the use of techniques for the creation of more neutral or fair sustainable rules, as well as contributing to the debate to promote issues relevant to economy and society. An important step in the history of a country cannot be given without a solid conceptual-theoretical basis, running the risk of resulting in unwanted cases of wealth transfers, enrichment of restricted groups of insured, or worse, the need for a new pension reform in the near future.

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APPENDIX

APPENDIX A MAIN PARAMETRIC CHANGES OF CONSTITUTIONAL AMENDMENT 287/2016 FOR URBAN RETIREMENT OF THE RGPS

	Version proposed by the executive branch (December, 2016)	Version altered by the legislative branch (November, 2017)	Version altered by the legislative branch (January, 2018)
TOOL FOR RETIREMENT BASED ON CONTRIBUTION NOTE: IT IS PART OF THE TRANSITION RULE FOR RETIREMENT BASED ON CONTRIBUTION PERIOD. TO BE EXTINCT FOR FUTURE PARTICIPANTS	50% of additional contribution, on top of the time remaining to complete 30 years (W) or 35 years (M) Note: Transition only for men over 50 years old and women over 45 years old. For yougers, it is applied 65 years of minimum age and 25 years of minimum contribution.	30% of additional contribution, on top of the time remaining to complete 30 years (W) or 35 years (M) Obs.: Transition for insured of any age. However, the tool will not be applied if it results in a minimum age higher than 62(W) or 65(M).	
MINIMUM AGE FOR RETIREMENT BASED ON CONTRIBUTION PERIOD NOTE: IT IS PART OF THE TRANSITION RULE FOR RETIREMENT BASED ON CONTRIBUTION PERIOD. TO BE EXTINCT FOR FUTURE PARTICIPANTS	65 years (W or M) No transition rules and with increase according to the increase of the life expectancy Note: There is no minimum age in the current rule for retirement based on contribution period. However, there is the retirement based on age when the insured is 60 years old (W) and 65 years old (M), if contributed for at least 15 years, with replacement ration of 85%, increased in 1% per year of additional contribution, limited to 100%	2018-2019 53(W) 55(M) 2020-2021 54(W) 56(M) 2022-2023 55(W) 57(M) 2024-2025 56(W) 58(M) 2026-2027 57(W) 59(M) 2028-2029 58(W) 60(M) 2030-2031 59(W) 61(M) 2032-2033 60(W) 62(M) 2034-2035 61(W) 63(M) 2036-2037 62(W) 64(M) From 2038 62(W) 65(M)	

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	Version proposed by the executive branch (December, 2016)	Version altered by the legislative branch (November, 2017)	Version altered by the legislative branch (January, 2018)
MINIMUM AGE FOR RETIREMENT BASED ON AGE **MINIMUM CONTRIBUTION** FOR RETIREMENT BASED ON AGE	65 years (W or M) No transition rules Note: current rule 60 (W) or 65 (M) 25 years, no transition rules Note: current rule 15 years	2018-2019: 60 years old (W) or 65 years old (M) 2020-2021: 61 years old (W) or 65 years old (M) From 2022: 62 years old (W) or 65 years old (M) 15 years (the current rule is maintained)	
NEW REPLACEMETN FOR ANY TYPE OF RETIREMENT	25 years = 76% 26 years = 77% 27 years = 78% 28 years = 79% 29 years = 80% 30 years = 81% 31 years = 82% 32 years = 83% 33 years = 84% 34 years = 85% 35 years = 86% 36 years = 87% 37 years = 88% 38 years = 89% 39 years = 90% 40 years = 91% 41 years = 92% 42 years = 93% 43 years = 94% 44 years = 95% 45 years = 96% 46 years = 97% 47 years = 98% 48 years = 99% 49 years or more = 100%	25 years = 70% 26 years = 71.5% 27 years = 73% 28 years = 74.5% 29 years = 76% 30 years = 77.5% 31 years = 79.5% 32 years = 81.5% 33 years = 83.5% 34 years = 85.5% 35 years = 87.5% 36 years = 90% 37 years = 92.5% 38 years = 95% 39 years = 97.5% 40 years or mores = 100%	15 years = 60% 16 years = 61% 17 years = 62% 18 years = 63% 19 years = 64% 20 years = 65% 21 years = 66% 22 years = 67% 23 years = 68% 24 years = 69% 25 years = 70% 26 years = 71.5% 27 years = 73% 28 years = 74.5% 29 years = 76% 30 years = 77.5% 31 years = 79.5% 32 years = 81.5% 33 years = 83.5% 34 years = 85.5% 35 years = 87.5% 36 years = 90% 37 years = 92.5% 38 years = 95% 39 years = 97.5% 40 years or more = 100%
REPLACEMENT (CURRENT RULE TO BE CANCELED	Retirement based on contribution period: Social security welfare factor and rule 85/95-90/100 (100% replacement) Retirement based on age: Percentage of 85% (15 years), 86% (16 years), 87% (17 years), ..., 100% (30 years or more).		

Continue

	Version proposed by the executive branch (December, 2016)	Version altered by the legislative branch (November, 2017)	Version altered by the legislative branch (January, 2018)
ACCRUED BENEFIT (AVERAGE) FOR ANY TYPE OF RETIREMENT	Average of the 80% higher wage contributions, inflation adjusted based on the INPC/IBGE (mantains the current rule)	Average of all wage contributions, inflation adjusted based on INPC/IBGE	
MINIMUM ACCRUED (FLOOR)	No Note: Current rule has a floor limit equals to a minimum wage	Minimum wage	
MAXIMUM ACCRUED **ACCUMULATION OF RETIREMENT PAYMENT AND OTHER BENEFITS**	Accumulation allowed only to reach the amount of a minimum wage Note: Current rule allows accumulation until reaching the top of the INSS ceiling	Accumulations allowed only to reach the amount of two minimum wages	
PERCENTAGE OF PENSION	50% + 10% per insured (spouse/partner or dependents), limited to 100% Ex.: only spouse = 60% Only one child = 60% Spouse and one child = 70% Spouse and four children = 100% Spouse and five children = 100% Note: Current rule has a percentage of 100%		

Source: Elaborated by the authors.