Social security reform: is the Brazilian pension system actuarially fair?

André Carvalho Penafieri
(SSPREV)
(penafieri@hotmail.com)

Luís Eduardo Afonso
University of São Paulo – Brazil)
(lafonso@usp.br)

ABSTRACT
The first goal of this paper is to compare the present calculation rule of the *Retirement for Contribution Time* (*ATC*) (the most significant old age benefit) with three proposals under analysis in the Brazilian congress: *Rule 85/95*, *Average 80% Highest Wages* and *Average Last 36 Wages* (*three years*). We used four comparison indicators: Replacement Rates, Internal Rates of Return, Effective Contribution Rates and Actuarially Fair Contribution Rates. The present formulation of Social Security Factor (an automatic balancing mechanism that is used to calculate old age benefits) penalizes (encourages) more than the actuarially fair early (late) retirement. The proposals are more generous than the current rule. If the Rule 85/95 was adopted, men and women would be affected in different ways. The second objective is to calculate the *Actuarially Fair Social Security Factor*. This is intended to be the Factor that should prevail in order to the Brazilian pension system should be classified as actuarially fair.

Keywords: Social Security; Retirement for Contribution Time, Brazil; Social Security Factor; Actuarial Fairness, Pension Reform.

1. INTRODUCTION

In Brazil, during President Fernando Henrique Cardoso government (1995-2002) two significant changes were made in the formula for calculating the old age benefit (*Retirement for Contribution Time - ATC*) of the national pension system. In 1998, the Congress approved the Constitutional Amendment 20 (EC 20), allowing the pension benefit formula to be defined by an ordinary law, and not anymore in the Constitution, as it was before. One year later, Law 9876 introduced the *Social Security Factor* (*SSF*), an automatic balancing mechanism (ABM) used to compute the value of the old age benefit. *SSF* is directly proportional to age and number of years of contribution and inversely proportional to life expectancy. It is a mechanism to discourage early retirement: the greater the time of contribution and the higher the age at the date of retirement, the higher the value of the benefit. After these changes, the value of ATC is calculated multiplying SSF by the average of 80% highest earnings.

Despite its correct actuarial foundations, many voices have been raised against *SSF*. In 2008 the Senate appreciated Bill 3299/08, amending the method for calculating the value of ATC, quenching SSF and restoring the previous rule: the value of the benefit would again be calculated as the arithmetic average of 36 last months before retirement, eliminating the incidence of Factor. When this proposal was sent the House of Representatives another change was proposed. Such an alternative has been designated as *Rule 85/95*. As a condition to obtaining the full benefit, the sum of the age with the number of years of contribution shall be equal to 95 for men (since the contributory period is not less than 35 years). For women, the sum must be equal to 85 (since the minimum contribution period is 30 years).

Another attempt to termination of *SSF* came in May 2010 when Congress passed the National Provisional Measure No. 475/09, which eliminated the SSF, claiming that this Factor drastically reduced the value of pensions and the embedded biometric risks should not be borne by the insured. However, such a measure was vetoed by then-President Luiz Inácio Lula da Silva.

The proposals listed above allow us to affirm that the discussions about SSF in Brazil have been overly binary: in favor of maintaining or towards its extinction. However, polar positions cannot assess the particularities of the pension rules and do rely on the concepts of actuarial literature, that can give a more accurate theoretical framework for the study of social security systems. Economic and actuarial criteria, as pointed out by Brown (2008) can provide a more precise understanding of the problem and serve as the basis for formulating more appropriate welfare policies. This situation is quite different from the USA, presented by Diamond (2006) in which discussions have relied on the expressive participation of researchers, in the formulation of proposals or taking part in the government. It is still valid for make an additional comment. The proposals in question are dissonant in relation to the alternatives under consideration or already implemented in other countries to cope with demographic changes, particularly with ABMs, as pointed Bosworth and Weaver (2011).

Based on this framework, this first goal of this paper is to analyze different formulas of calculating the ATCs, based on indicators commonly used in the international literature on pension systems (Replacement Rate, Internal Rate of Return, Effective Social Security Contribution Rate and Actuarially Fair Contribution Rate). The second objective is based on the perception that the present formulation of Social Security Factor (SSF) may not be the most appropriate instrument to achieve the desired balance between contributions and benefits, depending on the magnitude of the incentives and penalties for delay or postponement of retirement. For this reason, we present here the concept of *Actuarially Fair Social Security Factor* (*AFSSF*), a concept that is intended to be innovative. One important result is the gender differential: in the current formulation of the SSF women have greater incentives for late retirement, while men are more affected in case of early retirement.

This paper has five sections. The second section presents the theoretical characteristics of actuarial pension systems. The next section presents the characteristics and current rules of *Retirement for Contribution Time* (*ATC*) and the proposals under analysis in the Congress. The fourth section reports the results obtained for the four social security indicators. In the fifth section we present the deduction and calculate *Actuarially Fair Social Security Factor* (*AFSSF*). The sixth and final section presents the conclusions.

2. A BRIEF SURVEY OF THE LITERATURE

The theoretical framework for the analysis of the proposed changes in the formula for calculating Length of Retirement Pension is given by two key concepts: Actuarial Fairness and Actuarial Neutrality. As pointed out by Queisser and Whitehouse (2006, p. 7-8) and Börsch-Supan (2006, p. 50) a pension system is classified as *actuarially fair* if the expected present value of contributions are equal to the expected present value of benefits, for each individual. The pension system is actuarially neutral if the present value of marginal benefits (obtained by working an extra year) is equal to the marginal present value of contributions. It can be interpreted, based on Hassler and Lindbeck (1996) that the definition of actuarial neutrality implies the neutrality of the pension system with respect to the optimal decisions of labor supply. This occurs because, the terms of marginal increases (and decreases) in the present values of benefits and contributions should be equivalent.

The literature has developed considerably since the late 70s, particularly in the U.S., with results so far inconclusive. First studies have focused on the (dis) incentive to supply labor generated by social security. One of the first contributions was made by Sheshinski (1978), which concludes that social security induces early retirement. An opposite result was found by Blinder, Gordon and Wise (1980). For these authors just some groups of workers would be induced to reduce their labor supply. However, to Kahn (1988) the results of this trio of authors are not robust, since they essentially depend on the discount rate used.

Kifmann and Breyer (2002) point out that the effects of the particularities of pension systems, such as brackets and adjustment mechanisms on the labor decision are not, a priori, so clear. This result is corroborated by Keuschinigg and Fisher (2010). Based on the literature listed, it can be concluded that there are no clear answers regarding the actuarial fairness and actuarial neutrality. For this reason, it is necessary to resort to empirical studies that analyze to try to find more evidence on the subject.

Some other empirical contributions deserve to be listed. Reznik, Weaver and Biggs (2009) estimate the marginal returns (the gain obtained by the workers for an additional year in the labor market) for various combinations of gender, income level and number of years of contribution to SSA in the U.S. The results show that the average marginal return (-52.2 %) is below the average return (2.6%) of social security contributions. This is due to the progressive present in the formula for calculating pensions. Holzmann (2006) examines the pension systems of many European countries and concludes that in Austria and the Czech Republic there are incentives for early retirement. Systems from countries like Sweden and Poland can be classified as actuarially fair. Forteza and Ourens (2012) perform a similar exercise for 11 Latin American countries. The authors show that on average pension internal rates of return reach its maximum around the age of 63. After this age, pension systems provide incentives to exit the labor market.

Shoven and Slavov (2012a) made an important contribution, by studying the U.S. pension system. According to the authors, postponing retirement (until 70 years) may be the optimal strategy for married people. For unmarried individuals, there are also gains to the postponement, although the magnitude is much smaller. This provides evidence that the formula for calculating the benefits of the Social Security Administration (SSA) is not actuarially neutral. Another contribution by the same authors (Shoven and Slavov, 2012b) incorporates the differential mortality. They found significant evidence that postponing retirement may not be advantageous for individuals which mortality is above average. Similar conclusions are reached by Schroeder (2012), who shows that the German pension system discourages early retirement, both for men and women, due to lower rates of return obtained.

For the Brazilian case, must be cited some papers that focus on the effects of Social Security Factor. Cechin and Cechin (2007) argue that the Factor reduced the actuarial imbalance present in the pension system and established more contributive justice. Delgado et al. (2006) evaluated the results of the implementation of the Social Security Factor. The factor increased the average retirement age in about 2.5 years and the average contribution period in over a year, both for men and for women. For the authors, the factor generated savings of 11.1% in spending for social security retirement benefits granted in five-year period from 2000 to 2004. For Cruz et al. (2011) the result is even more impressive, with savings of 30 % in the 2000-2009 period. Giambiagi and Afonso (2009) calculated replacement rates for some groups of representative workers and found strong incentives to delay retirement, mainly because of the Social Security Factor.

It should be noted that despite the relevance of the papers that analyze the Brazilian case, two remaining gaps appear. The first is the fact that the authors have failed to employ indicators of standard use in the international literature on welfare. The second is that none of the papers presented focused his attention on the distributional aspects associated with the Social Security Factor, particularly with regard to actuarial fairness inherent (or not) to its formulation.

3. CURRENT RULES AND REFORM PROPOSALS

This section presents the main features of old age benefit (*Retirement for Contribution Time - ATC*) for employees, with respect to the form of contributions, benefit calculation and eligibility criteria. The choice of ATC is justified because this is the benefit with stronger link between contributions and benefits.

3.1. *Retirement for Contribution Time* (*ATC*) - Current Rule

In the Brazilian system, social security contributions are levied on the wage, with floor and ceiling from R$ 622.00 (*Brazilian Reais*) to R$ 3,916.20 (current values from January 1, 2012. At that time the exchange was circa US$ 1 = R$ 1.80). The social security contribution is divided between the employee and the employer. The employer contributory rate is 20% of the employee's wage. The contribution rate for the employee is shown in Table 1. Note that while the employee contributes on the salary base, which is bounded by the floor and ceiling R$ 622.00 to R$ 3,916.20, the employer contributes on the entire salary of the employee.

TABLE 1 – Social security contribution rate, by bracket (employee)

Income (R$)	Contribution rate (%)
0.00 – 1,174.86	8
1.174.87 – 1,958.10	9
1,958.11 -3,916.20	11

Source: MPS (2012)

To be entitled to the full benefit men must contribute at least for 35 years and women must contribute at least for 30 years. This is the only eligibility criteria. The value *Sb* of the old age benefit *ATC* (subject to the same floor and ceiling of the contribution wage) is calculated by multiplying the Social Security Factor *SSF* by the average *M* of the real 80% highest earnings during labor time, as shown in equation 1. For example, for a man with 35 years in the labor market, the 80% highest earnings correspond to 28 years.

$$Sb = f.M \tag{1}$$

The Social Security Factor (*SSF*) is given by equation 2:

$$SSF = \frac{Tc.a}{Es}.\left(1+\frac{Id+Tc.a}{100}\right) \tag{2}$$

Tc = Contribution time;
a = contribution rate (set at 0,31);
Es = survival expectancy on retirement date (given by the mortality table, both sexes prepared annually by the Brazilian Bureau of Labor and Statistics (IBGE);
Id = Age at time of retirement.

Tables 2 and 3 show values of the Social Security Factor (*SSF*) for various combinations of age and contribution time (years). In the calculation women are given a bonus of five years at the contribution time when calculating the factor, i. e. , if a woman retires after 30 years of contributions, the factor is calculated as if it had worked 35. The incidence of factor implies greater penalty for those who retire early age with time and contribution reduced. For example, for a man who retires at the age of 53, having contributed for 35 years, SSF is equal to 0.67. If this worker wants to retire with an old age benefit approximately equal to the average earnings, he would have to continue working for another six years, when the factor would be 0.99. On the other hand, there is a ceiling for the maximum benefit: even if SSF is equal or greater than 1, the highest old age benefit value *Sb* is R$ 3,916.20.

TABLE 2 – Social Security Factor - MEN

Contribution time	Retirement age														
	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67
35	0.67	0.69	0.71	0.74	0.77	0.80	0.83	0.87	0.90	0.94	0.98	1.02	1.07	1.12	1.17
36	0.69	0.71	0.74	0.76	0.80	0.82	0.86	0.89	0.93	0.97	1.01	1.05	1.10	1.15	1.21
37	0.71	0.73	0.76	0.79	0.82	0.85	0.88	0.92	0.96	1.00	1.04	1.08	1.13	1.18	1.24
38		0.75	0.78	0.81	0.84	0.87	0.91	0.95	0.98	1.03	1.07	1.11	1.16	1.22	1.28
39			0.80	0.83	0.87	0.90	0.94	0.97	1.01	1.06	1.10	1.14	1.20	1.25	1.31
40				0.86	0.89	0.92	0.96	1.00	1.04	1.09	1.13	1.18	1.23	1.29	1.35
41					0.91	0.95	0.99	1.03	1.07	1.12	1.16	1.21	1.26	1.32	1.38
42						0.97	1.01	1.05	1.09	1.15	1.19	1.24	1.29	1.36	1.42
43							1.04	1.08	1.12	1.17	1.22	1.27	1.33	1.39	1.46
44								1.11	1.15	1.20	1.25	1.30	1.36	1.42	1.49
45									1.18	1.23	1.29	1.33	1.39	1.46	1.53

Source: author's calculations.

Table 3 presents the Social Security Factor for women. Given that five years are added to the time of contribution, the women's Factor is higher than men' Factor, if both retire at the same age. For example, the Factor of a 53 year old woman with 35 years of contribution is 0.77. For a man with the same age and the same time of contribution, the factor is 0.67.

TABLE 3 – Social Security Factor - Women

Contribution time	Retirement age														
	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
30	0.56	0.58	0.60	0.62	0.64	0.67	0.69	0.71	0.74	0.77	0.80	0.83	0.87	0.90	0.94
31	0.58	0.60	0.62	0.64	0.66	0.69	0.71	0.74	0.76	0.80	0.82	0.86	0.89	0.93	0.97
32	0.59	0.61	0.63	0.66	0.68	0.71	0.73	0.76	0.79	0.82	0.85	0.88	0.92	0.96	1.00
33		0.63	0.65	0.68	0.70	0.73	0.75	0.78	0.81	0.84	0.87	0.91	0.95	0.98	1.03
34			0.67	0.69	0.72	0.75	0.78	0.80	0.83	0.87	0.90	0.94	0.97	1.01	1.06
35				0.71	0.74	0.77	0.80	0.82	0.86	0.89	0.92	0.96	1.00	1.04	1.09
36					0.76	0.79	0.82	0.85	0.88	0.91	0.95	0.99	1.03	1.07	1.12
37						0.81	0.84	0.87	0.90	0.94	0.97	1.01	1.05	1.09	1.15
38							0.86	0.89	0.93	0.96	1.00	1.04	1.08	1.12	1.17
39								0.91	0.95	0.99	1.02	1.07	1.11	1.15	1.20
40									0.97	1.01	1.05	1.09	1.13	1.18	1.23

Source: author's calculations.

3.2. Reform proposals

This section presents three proposals for parametric reforms for calculating the value *Sb* of the old age benefit *ATC* based on proposed changes that are in analysis in the Brazilian congress, at the time this paper was being written.

3.2.1. Proposal 1 - Average of the last 36 wages (three years)

Before the Constitutional Amendment 20 (EC 20) (1998), the old age benefit was simply the arithmetic average of the last 36 real wages. After nearly a decade of EC 20, the Senate approved a bill amending the formula for calculating the pension benefit. The law proposition extinguishes the Social Security Factor. If this proposal is approved the old age benefit would be again only by the average 36 last wages, as it was before the EC 20.

3.2.2. Proposal 2 - Rule 85/95

The second proposal is known as *Rule 85/95*. By this rule, to be eligible for retirement without using the Social Security Factor (in other words, with Factor equal to one), it is necessary that sum of the contribution time and age at the time of retirement is equal to 95 for men, with a minimum contribution period of 35 years. For women this sum must equal 85, with a contribution time of at least 30 years. If the sum does not reach 95 (for men) or 85 (for women) and the employee decides to retire, the benefit value will be calculated using with the Social Security Factor. It is also proposed that, instead of considering only the last 36 contributions, the benefit is calculated using the average of 70% highest wages. The benefit would be higher than today, because the worst 30 % wages would be discarded, and today just worst 20 % wages are discarded.

Table 4 shows how would be the Social Security Factor for men, in accordance with Rule 85/95. This table is constructed similarly to Tables 2 and 3, but with a Factor equal to one when the sum of age contribution time is greater than or equal to 95. For example, for a 56 year man with 38 years of contributions the Factor would be equal to 0.81. If he works for an extra year, his Factor would be equal to 1.00, an increase of over 23 %. In the current rule, the change would be from 0.81 to 0.86. It is clear that incentives to remain in the labor market would be changed as well the actuarial neutrality of the Brazilian pension system.

TABLE 4 – Social Security Factor - Rule 85/95 – Men

Contribution time	Retirement age														
	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67
35	0.67	0.69	0.71	0.74	0.77	0.80	0.83								
36	0.69	0.71	0.74	0.76	0.80	0.82									
37	0.71	0.73	0.76	0.79	0.82										
38		0.75	0.78	0.81											
39			0.80												
40											1,00				
41															
42															

Source: author's calculations.

Table 5 shows the values for SSF for women, in accordance with *Rule 85/*95. In this new arrangement there is a big difference when compared to the present rules. For example, the Factor for a 51 year woman with 32 years of contribution factor is to 0.66. If she continues on the labor market for an extra year, her Social Security Factor would be equal to 1.00. That is, a 50% increase in the Factor (and in benefit value).

TABLE 5 - Social Security Factor - Rule 85/95 – Women

Contribution time	Retirement age														
	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
30	0.56	0.58	0.60	0.62	0.64	0.67	0.69								
31	0.58	0.60	0.62	0.64	0.66	0.69									
32	0.59	0.61	0.63	0.66	0.68										
33		0.63	0.65	0.68											
34			0.67	0.69											
35				0.71							1,00				
36															
37															
38															
39															
40															
41															
42															

Source: author's calculations.

3.2.3. Proposal 3 - Average 80 % highest wages

The benefit value would be calculated as the arithmetic average of 80 % highest wages if the Social Security Factor ceased to exist, as suggested in another proposal under analysis.

4. EMPIRICAL PROCEDURE

4.1. Assumptions and initial values

To calculate the flows of contributions and benefits we employed representative individuals, following the contribution of Leimer (1999). The calculations were based on the following assumptions:

- **Income**: are used three levels of initial income: low income, middle income and high income. The initial values are respectively: R$ 622.00, R$ 1,244.00 and R$ 1,866.00. This represents one, two and three minimum wages in the year 2012 ;
- **Wage growth**: 2 % per year for the three income levels ;
- **Gender**: All results are expressed for men and women;
- **Expected survival**: mortality table both sexes, calculated by the Brazilian Government;
- **Real Discount Rate** : 3 % per year;
- **Density** = 100 % of contributions: it is assumed that there is no interruption in the contributory period, periods of unemployment or informality.
- **Contributions**: Brazilian pension system rules, as presented in section 3.1;
- **Calculation of old age benefit**: we calculated the benefit in four different ways: Current Rule, average of the last three years (36 months), Rule 85/95 and average of 80% highest wages.

Before presenting the main results of this section is important to show the values (Table 6) of the monthly old age benefits *Sb* (i.e., the value of ATC) for each of the four rules analyzed. These results are reported for the combinations three income levels, three combinations of retirement age and contribution time (CT) (51 years and 35 years of contribution; 60 years and 35 years of contribution and 70 years and 35 years of contribution) for both genders. Any of the proposals under study generate higher benefits than the current rule.

TABLE 6 – Old-age survivor benefit (*Sb*) (R$)

Age/CT	Income	Present rule		Rule 85/95		Average 80% highest	Average last 3 years
		Men	Women	Men	Women		
51 / 35	Low	622.00	674.51	622.00	971.43	945.44	1,195.78
	Medium	1,177.50	1,349.03	1,209.86	1,942.87	1,890.89	2,391.57
	High	1,766.24	2,023.54	1,814.80	2,914.30	2,836.33	3,587.35
60 / 35	Low	818.97	944.45	971.43	971.43	945.44	1,195.78
	Medium	1,637.94	1,888.91	1,942.87	1,942.87	1,890.89	2,391.57
	High	2,456.90	2,833.36	2,914.30	2,914.30	2,836.33	3,587.35
70 / 35	Low	1,262.02	1,454.67	971.43	971.43	945.44	1,195.78
	Medium	2,524.04	2,909.34	1,942.87	1,942.87	1,890.89	2,391.57
	High	3,786.07	3,916.20	2,914.30	2,914.30	2,836.33	3,587.35

Source: author's calculations.

4.2. Replacement rates (*TR*)

In order to compare the proposals we used four widespread indicators in the welfare literature (see, for example, and Forteza Ourens, 2009). The first is one the Replacement Rate (*TR*), which expresses the relationship between the values of the first benefit received by the employee (A_{N+1}) and the last wage before retirement (W_N). The *TR*, presented in equation 3 represents the transition of income received when the worker leaves the job market. The interpretation is straightforward. It represents a proxy of the perception that the employee has over a possible reduction in his real income after retirement.

$$TR = \frac{A_{N+1}}{W_N} \quad (3)$$

Based on the values reported in Table 6 we calculated the Replacement Rate *TR*. These results are shown in Table 7. The TRs for benefits calculated according to the current rule are influenced by Social Security Factor in the three combinations of retirement age and contribution time. A 70 year old woman with low income, and 35 years of contribution have TR of 1.19, as her Social Security Factor is equal to 1.54. This means that her initial benefit is 119 % of her last salary. Conversely, the lower TR is found for a man of high income who retires at age 51, after 35 years of contribution, because his Social Security Factor is equal to 0.62. For this group of men, the replacement rate is higher for those with lower incomes. The reason is that the value of their retirement would be less than the minimum old age benefit (1 minimum wage), which would be incompatible with the current legislation. Thus, mimicking the procedure of Social Security, the amount has to be increased to 1 MW, which explains the higher TR. The same argument holds for women with equal contribution period and age. In the case of combination 70/35, the reasoning is the opposite. The benefit would exceed the ceiling and therefore has to be decreased.

TABLE 7 – Replacement rates (*TR*)

Age/CT	Income	Present rule		Rule 85/95		Average 80% highest	Average last 3 years
		Men	Women	Men	Women		
51 / 35	Low	0.5100	0.5531	0.5100	0.7966	0.7752	0.9805
	Medium	0.4828	0.5531	0.4960	0.7966	0.7752	0.9805
	High	0.4828	0.5531	0.4960	0.7966	0.7752	0.9805
60 / 35	Low	0.6715	0.7744	0.7966	0.7966	0.7752	0.9805
	Medium	0.6715	0.7744	0.7966	0.7966	0.7752	0.9805
	High	0.6715	0.7744	0.7966	0.7966	0.7752	0.9805
70 / 35	Low	1.0348	1.1928	0.7966	0.7966	0.7752	0.9805
	Medium	1.0348	1.1928	0.7966	0.7966	0.7752	0.9805
	High	1.0348	1.0704	0.7966	0.7966	0.7752	0.9805

Source: author's calculations.

The Replacement Rates for *Rule 85/95* are influenced by the Social Security Factor when the eligibility requirements for obtaining full pension are not met, what happens in the case of men (except for the combination 60/35). It is worth noting that the Replacement Rate of a 70 year old man who contributed for 30 years is greater than it would be if he had contributed for 35 years, for example. This is due the criteria of *Rule 85/95*: when the sum of age at contribution time is greater than or equal to 95, the Social Security Factor is equal to 1. As the sum of age and years of contribution of a man aged 70 to 30 years of contribution is less than 95, the Social Security Factor (which value is 1.13) is used to calculate the value of the benefit. When the employee does not meet the requirements of *Rule 85/95* (combination 51/35), the Social Security Factor is used in the calculation of the benefit, which explains the low TRs found.

The benefits calculated by the average of 80 % highest wages and those calculated by the average of the last three years have TRs constants for the three combinations, and the benefits to the larger TRs are those calculated by the average of the last three years of contribution, with the exception of men and women aged 70 and 35 years of contributions, calculated by the current rule. In the last two cases, the values are the same for men and women, given that there would be no differentiation by gender. In the first combination of age and length of contribution (51/35) replacement rates for men in Rule 85/95 are very similar to those found for the current rule. For women, the average increase is 44% for Rule 85/95, 40% for the average of 80 % highest wages and 67% for the average of the last three years. For other combinations of age and length of contribution, the results are reversed, given that the current rule TRs are higher and the other alternatives, the values are constant. For example, for the combination 70/35, the Rule 85/95 represents roughly about 2/3 of the values found for the current rule. For the average of the last three years, the ratio is on average 90%.

4.3. Internal Rates of Return (*IRR*)

The second indicator is the IRR. This is the discount rate that equals the present values of contributions (for *N* periods from the beginning of working life) and pension received by each individual (from the time of retirement until the expected survival *Es*). The *IRR* is given by equation 4.

$$\sum_{t=1}^{N} \frac{Contribution_t}{(1+IRR)^t} = \sum_{t=N+1}^{Es} \frac{Benefit_t}{(1+IRR)^t} \tag{4}$$

Table 8 shows the *IRR* for the same groups of representative workers of Table 7. There is progressivity in the *TIR*s in all cases. I. e., individuals with lower income have the highest *IRR*s and individuals with higher income profiles s get the lower *IRR*s. Also note that the *IRR*s of women are higher than *IRR*s for men. With the exception of the combination 70/35, the highest IRRs are those associated with benefits calculated by the average of the last three years, what is explained by Factor that is higher than 1.

TABLE 8 – Internal Rates of Return (*IRR*) (% per year)

Age/CT	Income	Present rule		Rule 85/95		Average 80% highest	Average last 3 years
		Men	Women	Men	Women		
51 / 35	Low	2.37	2.64	2.37	3.87	3.78	4.56
	Medium	2.00	2.46	2.09	3.69	3.60	4.39
	High	1.87	2.33	1.96	3.55	3.46	4.25
60 / 35	Low	2.62	3.14	3.24	3.24	3.14	4.00
	Medium	2.41	2.94	3.05	3.05	2.95	3.81
	High	2.27	2.80	2.90	2.90	2.80	3.66
70 / 35	Low	3.17	3.75	2.10	2.10	1.99	2.96
	Medium	2.95	3.53	1.86	1.86	1.75	2.73
	High	2.79	2.93	1.71	1.71	1.59	2.57

Source: author's calculations.

As expected, on average, the IRRs are greater when the criteria for the calculation of the benefit are less rigid. As the criteria for calculating benefits for current rule is less stringent for women, they always have IRRs greater than those form men.

In the Current Rule and in the Rule 85/95, the IRRs are proportional to the Social Security Factor: the higher the age and the time of contribution, the higher the IRR. The benefits are calculated using the average of the top 80% wages and the average of wages of the last three years (which do not use the Social Security Factor) have TIRs inversely proportional to the age of retirement and number of years of contribution. Therefore these alternatives, if they were adopted, would be more advantageous to those who retire early and contribute for a minor period. This is reasonable evidence that the adoption of such measures strongly encourage early retirements.

The data in Table 8 give rise to some thoughts on the progressivity of the current rule and the three proposals analyzed with respect to differences of gender and income level between individuals. In the current rule, the IRR for men with higher income, for the first combination Age/Contribution time (51/35) is 79 % of the lower income group (1,87/2,37). For women, the ratio is 88%. For the proposals under analysis, the values are slightly higher. For the second combination of age and contribution time, the results are quite similar. As to the third combination, the results are reversed in the case of Rule 85/95. But when the focus on the gender difference, Rule 85/95 is more progressive for the combination 51/35, but it is neutral for the two following combinations. Thus, one cannot say unconditionally that some rule is more progressive than the other, as the results seem to depend on the income level and the different combinations of age and years of contribution.

4.4. Effective contribution rates and actuarially fair contribution rates

This section presents two indicators, closely related to each other: the Actuarially Fair Contribution Rate (a_{fair}) and the Effective Contribution Rate (a_{ef}). In the first case, the goal is to find a contribution rate that matches the values of the present values of flows of contributions and benefits, as shown in Equation 5, in which (*VPA*) is the present value of old age benefits and (*VPR*) is the present value of income. It's the contribution rate that should be charged jointly to the employee and the employer, so that he could live up to the expected benefit. In the second case, the aim is to calculate the ratio between the present values of contributions (VPC) and the worker income (*VPR*), as shown in Equation 6. This rate corresponds to how much the worker has contributed effectively in relation to their income.

$$a_{fair} = \frac{VPA}{VPR} \qquad (5)$$

$$a_{ef} = \frac{VPC}{VPR} \qquad (6)$$

Table 10 presents the results of the Actuarially Fair Contribution Rate (a_{fair}) and Table 11, Effective Contribution Rate (a_{ef}) for the same combinations of gender, income, age and length of contribution presented earlier in the text.

In the current rule, in most cases, the Actuarially Fair Contribution Rates are lower than those that actually prevail (28-31%). The rates increase with higher retirement ages because of increasing values of Social Security Factor. And the rates for women are always higher than those of men, which is evidence of cross-subsidization by gender. In the case of the averages for the last three years and 80 % highest wages, the opposite occurs: the lower the retirement age, the higher the Actuarially Fair Contribution Rate. The reason is that there is no incidence of Factor and early retirements imply receive benefits for a longer period, which implies a higher contribution rate. In Rule 85/95 the results show no monotonicity. The reason is that women can retire earlier than men (without Factor), her fair rate is higher for the combination 51/35. For other ages, both genders reach eligibility requirements and there is no incidence of Factor. Thus, the fair rate decreases with increasing retirement age, because the shorter number of years receiving the benefit. Figures for this indicator repeat the pattern shown in Tables 7 and 8: the values for the new rules are higher for the combination 51/35 and the results are reverted for higher contribution periods and ages.

TABLE 9 – Actuarially Fair Contribution Rate (a_{fair}) (%)

Age/CT	Income	Present rule		Rule 85/95		Average 80% highest	Average last 3 years
		Men	Women	Men	Women		
51 / 35	Low	23.26	25.23	23.26	36.33	35.36	44.73
	Medium	22.02	25.23	22.63	36.33	35.36	44.73
	High	22.02	25.23	22.63	36.33	35.36	44.73
60 / 35	Low	25.28	29.15	29.98	29.98	29.18	36.91
	Medium	25.28	29.15	29.98	29.98	29.18	36.91
	High	25.28	29.15	29.98	29.98	29.18	36.91
70 / 35	Low	29.29	33.76	22.54	22.54	21.94	27.75
	Medium	29.29	33.76	22.54	22.54	21.94	27.75
	High	29.29	30.29	22.54	22.54	21.94	27.75

Source: author's calculations

For the effective rates a_{ef} , by hypothesis, the calculation takes into account the income and the contributions. Thus, the period of receiving the benefit and how its value is calculated does not influence the results. There are no differences between the different alternatives. What explains the differences is the initial income: the higher it is, the sooner the higher rates, (given by Table 1) are reached. Thus, the rates are monotonically increasing with income worker. For consistency with the presentation of the other indicators, we report all results, although these are the same for every row of the Table 10.

TABLE 10 – Effective Contribution Rate (a_{ef}) (%)

Age/CT	Income	Present rule		Present rule		Average 80% highest	Average last 3 years
		Men	Men	Men	Men		
51 / 35	Low	28.05	28.05	28.05	28.05	28.05	28.05
	Medium	29.61	29.61	29.61	29.61	29.61	29.61
	High	30.80	30.80	30.80	30.80	30.80	30.80
60 / 35	Low	28.05	28.05	28.05	28.05	28.05	28.05
	Medium	29.61	29.61	29.61	29.61	29.61	29.61
	High	30.80	30.80	30.80	30.80	30.80	30.80
70 / 35	Low	28.05	28.05	28.05	28.05	28.05	28.05
	Medium	29.61	29.61	29.61	29.61	29.61	29.61
	High	30.80	30.80	30.80	30.80	30.80	30.80

Source: author's calculations

5. ACTUARIALLY FAIR SOCIAL SECURITY FACTOR (*AFSSF*)

5.1. The concept of the Actuarially Fair Social Security Factor (*AFSSF*)

With the creation of Social Security Factor the government sought to establish greater fairness and actuarial neutrality (as those terms are presented in section 2) to ATCs, since the value of the benefit has to be influenced by life expectancy in an inversely proportional way and in a directly proportional way to the contribution period and the age of retirement. The foundation is straightforward: early retirements are *punished* with lower benefits. Postponing retirement is *rewarded* with higher benefits. Although the qualitative reasoning behind Social Security Factor is sound and consistent, it still may not represent an accurate adjustment mechanism, on an actuarial basis. The results presented in the previous section reinforce this evidence.

As mentioned in the introduction, the political debate on the appropriateness of the use of Social Security Factor in calculating the value of pensions has been excessively binary, against or favorable to its use. We argue that the arguments of this discussion have not focused on relevant aspects, nor based on technical and actuarial grounds, as it should occur. The formula for calculating the value of old age benefit *ATC*, although simple, has brackets and nonlinearities given, for example, by different employee contribution rates by income, there are upper and lower limits for the value of benefits and contributions and the life expectancy (part of the calculation of the Factor) has increased yearly. Based on the fact that these peculiarities and complexities of the Brazilian pension system are not being addressed in due form, it seems valid to ask two questions that deserve deeper analysis:

- The *ad hoc* formula of *Social Security Factor* is really appropriate?
- The magnitude of incentives (punishments) to late (early) retirement is enough for workers to postpone (not anticipate) their retirement?

It is necessary to note that the term *adequacy* and the questions asked earlier, given the focus and methodological choices of this paper, do not focus on the possible (and very relevant) reduction in expenses that Factor has provided. This work is based on the concept of actuarial justice, inherent to the calculation of the value and the eligibility conditions of the ATC. That is, if the formula for calculating this benefits equals the present values of flows of contributions and benefits. Since there is a vector of observable characteristics (especially gender, level of initial income and retirement age) that make up a picture of intragenerational heterogeneity rather important for the pension indicators, it is relevant to understand how individuals with particular characteristics are affected by the social security legislation particularly because the Social Security Factor is an important part of the formula for calculating the value of ATC. The relevance of this argument is given, for example, in the contributions of Gustman; Steinmeier (2001) and Gustman et al. (2012).

Given this diagnosis and the issues raised, this section develops the *Actuarially Fair Social Security Factor* (*AFSSF*). This construct aims to adjust the value of the old age benefit *ATC* in order to obtain the actuarial equilibrium between the flows of contributions and benefits. Once we calculated AFSSF, this will be compared to Social Security Factor currently in effect. To calculate the AFSSF, we used the model developed in Giambiagi and Afonso (2009). Equation 7 calculates the present value of the flow of contributions *VPC* for *N* years. In this expression W_t is the wage in year *t*; α_t is the contribution rate in year *t* and *i* is the discount rate.

$$VPC = \sum_{t=1}^{N} \frac{\alpha_t . W_t . (1+i)^{N-t}}{(1+i)^N} \qquad (7)$$

The present value of old age benefit *VPA* is shown in equation 8. In this expression, *B* is the old age benefit calculated using the average higher 80% wages and the difference between *Es* and *N +1* corresponds to the number of years of retirement, according to life expectancy *Es*.

$$VPA = \sum_{t=N+1}^{Es} \frac{B}{(1+i)^t} \qquad (8)$$

Equation 8 can also be written as follows:

$$VPA = \frac{B}{(1+i)^N} . \left(\frac{(1+i)^{Es} - 1}{i.(1+i)^{Es}} \right) \quad (9)$$

For a pension system to be considered as actuarially fair, the expected present value of contributions (VPC) must be equal to the expected present value of pensions (VPA):

$$VPC = VPA \quad (10)$$

Using this concept, one can construct the *Actuarially Fair Social Security Factor* (*AFSSF*), which considers the old age benefit, so that *VPC* equals *VPA*. As the value and the flow of retirement benefits are influenced by life expectancy and the flow of contributions is known at the time of retirement, the actuarial balance can be achieved by adjusting the old age benefit. The next step is to calculate the Actuarially Fair Social Security Benefit ($B_{Atuarial}$) based on *VPC*. Substituting (8) into (7) isolating and B have:

$$B = VPC.(1+i)^N . \left(\frac{(1+i)^{Es} - 1}{i.(1+i)^{Es}} \right)^{-1} \quad (11)$$

By replacing *B* for $B_{Atuarial}$, equation 11 becomes:

$$B_{Atuarial} = VPC.(1+i)^N . \left(\frac{(1+i)^{Es} - 1}{i.(1+i)^{Es}} \right)^{-1} \quad (12)$$

The term $B_{Atuarial}$ can be understood as the old age benefit which present value is strictly equal to the present value of the contributions. So AFSSF is that value that adjusts the real value of the benefit *B* to the actuarially balanced value of the benefit $B_{Atuarial}$, according to equation 13:

$$AFSSF = \frac{B_{Atuarial}}{B} \quad (13)$$

5.2. Results for *AFSSF*

Based on deduction from the previous section, particularly the equation 13, we report in Table 11 the results of *AFSSF* (in bold) compared with the Social Security Factor for women (F-W) and the factor for men (F-M) for individuals middle income, using a discount rate of 3 %. There is no gender difference in AFSSF because its construction is intrinsic to the flows of contributions and benefits. The life expectancy used in the Social Security Factor and AFSSF is given by the mortality table for both sexes.

In 52 of the 110 combinations of Table 11, the AFSSF is greater than the Social Security Factor for men and women. It is also observed that in 53 of the 110 combinations AFSSF is between the values of Factor for men and for women. This means that in these cases the methodology of calculation of ATC places more burned on men than necessary to achieve actuarial balance between contributions and benefits. On the other hand, it benefits women with a factor larger than necessary: the effects of Factor are different by gender: men are more punished for early retirement, and women are more prized by delaying their retirement.

TABLE 11 – Actuarially Fair Social Security Factor (*AFSSF*)

Years of contribution		Retirement age									
		52	54	56	58	60	62	64	66	68	70
30	**AFSSF**	**0.68**	**0.71**	**0.74**	**0.77**	**0.81**	**0.86**	**0.90**	**0.96**	**1.02**	**1.08**
	F-M	0.55	0.59	0.63	0.68	0.74	0.80	0.87	0.95	1.04	1.13
	F-W	0.64	0.69	0.74	0.80	0.87	0.94	1.02	1.12	1.22	1.33
31	**AFSSF**	**0.72**	**0.75**	**0.78**	**0.81**	**0.85**	**0.90**	**0.95**	**1.00**	**1.07**	**1.13**
	F-M	0.57	0.61	0.65	0.70	0.76	0.83	0.90	0.98	1.07	1.17
	F-W	0.66	0.71	0.76	0.82	0.89	0.97	1.05	1.15	1.26	1.38
32	**AFSSF**	**0.75**	**0.78**	**0.82**	**0.85**	**0.89**	**0.94**	**0.99**	**1.05**	**1.12**	**1.19**
	F-M	0.59	0.63	0.67	0.73	0.79	0.86	0.93	1.01	1.11	1.21
	F-W	0.68	0.73	0.79	0.85	0.92	1.00	1.08	1.18	1.29	1.42
33	**AFSSF**	**0.78**	**0.81**	**0.85**	**0.88**	**0.93**	**0.98**	**1.03**	**1.09**	**1.16**	**1.23**
	F-M	0.61	0.65	0.70	0.75	0.81	0.89	0.96	1.05	1.15	1.25
	F-W	0.70	0.75	0.81	0.87	0.95	1.03	1.11	1.22	1.33	1.46
34	**AFSSF**	**0.82**	**0.85**	**0.89**	**0.93**	**0.97**	**1.02**	**1.08**	**1.14**	**1.21**	**1.29**
	F-M	0.63	0.67	0.72	0.78	0.84	0.91	0.99	1.08	1.18	1.29
	F-W	0.72	0.78	0.83	0.90	0.97	1.06	1.14	1.25	1.37	1.50
35	**AFSSF**	**0.85**	**0.89**	**0.93**	**0.97**	**1.01**	**1.07**	**1.12**	**1.19**	**1.27**	**1.35**
	F-M	0.64	0.69	0.74	0.80	0.87	0.94	1.02	1.12	1.22	1.33
	F-W	0.74	0.80	0.86	0.92	1.00	1.09	1.18	1.29	1.41	1.54
36	**AFSSF**	**0.89**	**0.93**	**0.97**	**1.01**	**1.06**	**1.12**	**1.17**	**1.25**	**1.32**	**1.41**
	F-M	0.66	0.71	0.76	0.82	0.89	0.97	1.05	1.15	1.26	1.38
	F-W	0.76	0.82	0.88	0.95	1.03	1.12	1.21	1.32	1.44	1.58
37	**AFSSF**	**0.93**	**0.97**	**1.01**	**1.05**	**1.11**	**1.17**	**1.23**	**1.30**	**1.38**	**1.47**
	F-M	0.68	0.73	0.79	0.85	0.92	1.00	1.08	1.18	1.29	1.42
	F-W	0.78	0.84	0.90	0.97	1.05	1.15	1.24	1.36	1.48	1.62
38	**AFSSF**	**0.96**	**1.00**	**1.04**	**1.09**	**1.14**	**1.20**	**1.27**	**1.34**	**1.43**	**1.52**
	F-M	0.70	0.75	0.81	0.87	0.95	1.03	1.11	1.22	1.33	1.46
	F-W	0.80	0.86	0.93	1.00	1.08	1.17	1.27	1.39	1.52	1.66
39	**AFSSF**	**1.00**	**1.04**	**1.09**	**1.13**	**1.19**	**1.26**	**1.32**	**1.40**	**1.49**	**1.58**
	F-M	0.72	0.78	0.83	0.90	0.97	1.06	1.14	1.25	1.37	1.50
	F-W	0.82	0.88	0.95	1.02	1.11	1.20	1.30	1.42	1.56	1.70
40	**AFSSF**	**1.04**	**1.09**	**1.13**	**1.18**	**1.24**	**1.31**	**1.37**	**1.46**	**1.55**	**1.65**
	F-M	0.74	0.80	0.86	0.92	1.00	1.09	1.18	1.29	1.41	1.54
	F-W	0.84	0.90	0.97	1.05	1.13	1.23	1.33	1.46	1.60	1.75

Source: author's calculations

For both genders, for relatively low retirement ages, the Social Security Factor is less than the AFSSF in almost all periods of contribution. For example, for a 58 year old man with 38 years of contribution, the Factor is 0.87 and 1.00 for a woman with the same characteristics. For the same individuals AFSSF is 1.09. This means that instead of the employee have the benefit reduced by 13% (if there was no incidence of Factor), it should be increased by 9%. In general, the Factor strongly discourages workers, particularly males, to anticipate their retirement. And on the opposite way, it gives stronger incentives to postpone retirement for women. The results provide some evidence that the Factor does not meet the criteria of fairness and actuarial neutrality as defined by Queisser and Whitehouse (2006) and Börsch-Supan (2006), particularly for ages and vesting periods shorter and longer. On the other hand, it is important to emphasize that the non-fulfillment of these conditions is consistent with the purpose underlying the creation of the Factor, which was discourage (encourage) early (late) retirement. If the Factor was actuarially neutral, the main goal of influencing labor supply and retirement, by providing such incentives and disincentives to workers wouldn't be fulfilled. Therefore, it can be concluded that the incorporation of the Social Security Factor on the calculation formula of the ATC had asymmetric effects on men and women. Both are penalized for early retirement and prized for late retirement. However, the penalty is stronger for men and incentives are stronger for women.

5.3. A sensitivity analysis of the results of *AFSSF*

The analysis of Table 11 allows a questioning about the sensitivity of the values reported in relation to changes in the parameters, particularly the discount rate *i*. The Fair Factor *AFSSF* is given by equation 13. The denominator of this fraction is the value of the benefit *B* that is not affected by the discount rate. Therefore, it is necessary to check the behavior of the term $B_{atuarial}$ (expression 12) when the value of *i* changes. This deduction gives rise to the expression 14. For all the tested values for parameters *I*, *N* and *Es* value of the derivative is positive. We can conclude that increases in the discount rate increase the actuarially fair benefit $B_{atuarial}$ and thus the Social Security Factor actuarially fair AFSSF. These conclusions are corroborated by the results of Table 12, which presents the results of *AFSSF* for a discount rate *i* of 5%. As can be noticed, the results undergo a significant change, in accordance with the literature. An average increase of 67% in the discount rate (3 to 5 %) results in an average increase of more than 72% in AFSSF, when we compare the values with those reported in Table 11. The largest increases are observed for combinations of higher contribution periods and lower retirement ages.

$$\frac{dB_{Atuarial}}{di} = VPC.N.(1+i)^{N-1}\frac{i(1+i)^{Es}}{(1+i)^{Es}-1} + (1+i)^{N}\frac{\left((1+i)^{Es} + i.Es(1+i)^{Es-1} - i.Es(1+i)^{Es}(1+i)^{Es-1}\right)}{\left((1+i)^{Es}-1\right)^{2}} > 0 \quad (14)$$

TABLE 12 - Actuarially Fair Social Security Factor (*AFSSF*) (Discount rate 5%)

Years of contribution	Retirement age									
	52	54	56	58	60	62	64	66	68	70
30	1.16	1.20	1.24	1.28	1.33	1.38	1.44	1.51	1.59	1.68
31	1.24	1.27	1.31	1.36	1.41	1.47	1.53	1.61	1.69	1.78
32	1.31	1.35	1.39	1.44	1.49	1.56	1.62	1.70	1.79	1.89
33	1.37	1.42	1.46	1.51	1.57	1.63	1.70	1.79	1.88	1.98
34	1.46	1.50	1.54	1.60	1.66	1.73	1.80	1.89	1.99	2.10
35	1.54	1.58	1.63	1.69	1.75	1.83	1.91	2.00	2.11	2.22
36	1.63	1.67	1.72	1.78	1.85	1.93	2.01	2.11	2.22	2.35
37	1.72	1.77	1.82	1.88	1.96	2.04	2.12	2.23	2.35	2.48
38	1.79	1.85	1.90	1.97	2.04	2.13	2.22	2.33	2.46	2.59
39	1.89	1.95	2.01	2.08	2.16	2.25	2.34	2.46	2.59	2.73
40	1.99	2.05	2.11	2.19	2.27	2.37	2.47	2.59	2.73	2.87

Source: author's calculations

6. CONCLUSIONS

The results show that the proposed change in the method of calculating ATCs deserve a very carefully analysis. The proposals, as well as the current rule, bring implicit nonlinearities, particularly in the calculation of Social Security Factor and Rule 85/95. There are also brackets given by contribution rates that vary with income and the upper and lower bounds for wages and benefits. These specificities should require caution on the part of Brazilian pension policymakers.

This study sought to quantitatively assess these reform proposals, based on a series of indicators extensively used in the literature on welfare: the Internal Rate of Return (*IRR*) Replacement Rate (*TR*), Actuarially Fair Contribution Rate (a_{fair}) and the Effective Contribution Rate (a_{ef}). Additionally, we developed a new construct: the Actuarially Fair Social Security Factor (*AFSSF*). The theoretical framework underlying the empirical work is given by the literature on actuarial fairness and actuarial neutrality, mainly supported by the contributions of Queisser and Whitehouse (2006), Börsch - Supan (2006) and also in Hassler and Lindbeck (1996).

The results lead to some major conclusions. The first is that the alternative calculation of ATC shows, on average, higher TRs and IRRs when compared to the current rule, which value of the benefit is strongly influenced by the Social Security Factor. The second conclusion is that the Factor, in many cases, reduces the benefit more than necessary to establish the actuarial balance between contributions and benefits, in the cases of early retirement. And, in the opposite case, postponing retirement increases more than proportionally the value of ATC.

The proposals we analyzed have very different TRs. In the current rule, there is an incentive to the postponement of retirement. In other proposals, with the exception of Rule 85/95 for men, in the combination 51/35, the TRs are the same for all cases. Note that all proposals are more generous, since they increase TRs compared to the current rule, except for case 70/35, which TRs exceed one, due to the incidence of Factor. The highest TRs are found in the proposal of calculating the benefit by the average of the last three years.

There is progressivity in the present situation and in all proposals, when the comparison criteria are the IRRs. Low-income individuals face higher IRRs than the high-income workers. The benefits calculated by the current rule had the lowest IRRs, and men have always lesser rates than women, which is an evidence of a cross-subsidy mechanism, explained partially by the bonus given in the time of contribution to women. These results allow us to conclude that, under this criterion, the distributive characteristics existing today will not cease to exist, if any proposal is approved. But its magnitude will increased, whatever proposal we pick. On the other hand, if any of the criteria of the means to be adopted, the implicit subsidies of men to women cease to exist, since differentiation by gender is not contemplated in these rules.

These results were the basis for the elaboration of the Actuarially Fair Social Security Factor (*AFSSF*), which aims to bring an original contribution to literature pension applied to Brazil, based on the Automatic Balancing Mechanisms (ABM) literature. The results of AFSSF reported in Table 11 showed that in most cases the Social Security Factor rewards (punishes) more than that actuarial fair the postponing (delaying) of retirements. In almost half the cases, the AFSSF is between the values of the Factor for men and Factor for women. This leads to two conclusions. The first is the existence of cross-subsidies between men and women, given the benefit women receive in the current formulation of the Social Security Factor. The second is the calculation formula of Retirement by Contribution Time does not meet the requirements of actuarial fairness or actuarial neutrality. On the other hand, it should be recognized that the Factor was incorporated into the formula for calculating this benefit precisely with this intention. That is, by construction, the Factor should not be actuarially fair. This is similar outlook to the one described by Börsch-Supan (2000) for the German case.

In only five of the 110 combinations of Table 11 AFSSF is smaller than the Factor for both genders. This occurs in the unlikely cases where the contributory period is reduced and the retirement age is raised. In these cases the Factor benefits the individuals who retire later with contributory period relatively short and the Factor increases the benefit amount more than the actuarially necessary. On the other hand, individuals with retirement age between 52 and 54 years (typical in Brazil) are burdened more than the actuarially fair. For example, the *AFSSF* for a 54 year old retired after 35 years of contribution is 0.89. For a man with such features is the Factor is 0.69 and for a woman, 0.80.

When the *AFSSF* is greater than one, the contribution rate is greater than the value necessary for the actuarial balance between contributions and benefits. It is important to make the caveat that the rules of the Brazilian pension system cannot be adequately understood by individuals, given their complexity and the long time horizon involved in social security issues. In the Brazilian case, this may be exacerbated by the nonlinearities inherent in the calculation of Social Security Factor (mainly because life expectancy) and the effects resulting from the presence of upper and lower limits for contributions and benefits, as well as the varying contribution rates levied on the wage of workers, ranging on income. In this case, as shown by Liebman, Lüttmer and Seif (2009), the behavior of individuals may be less than optimal, which would justify studies that explored this possibility.

7. REFERENCES

ANDREWS, D. **A review and analysis of the sustainability and equity of social security adjustment mechanisms**. 143 f. Tese (Doutorado em Ciências Atuariais) – University of Waterloo, Ontário, 2008.

BINSWANGER, J.; SCHUNK, D. What is an adequate standard of living during Retirement? **Journal of Pension Economics and Finance**, v. 11, n. 2, p. 203-222, 2011.

BLINDER, A. S.; GORDON, R. H.; WISE D. E. Reconsidering the work disincentive effects of social security. **National Tax Journal**, v. 33, n. 4, p. 431-442, 1980.

BOSWORTH, B; WEAVER, R. K. **Social security on auto-pilot: international experience with automatic stabilizer mechanisms**. Center for Retirement Research at Boston College, WP 2011-18, 2011.

BÖRSCH-SUPAN, A. Incentive effects of social security on labor force participation: evidence in Germany and across Europe. **Journal of Public Economics**, v. 78, Issues 1–2, p. 25–49, 2000.

BÖRSCH-SUPAN, A. H. What are NDC systems? what do they bring to reform strategies? In: HOLZMANN, R.; PALMER.; E. (Ed.) **Pension reform:** Issues and prospects for non-financial defined contribution (NDC) schemes. The World Bank: Washington, D.C., 2006. cap. 3, p. 35-75.

BREYER, F.; KIFMANN, M. Incentives to retire later – a solution to the social security crisis? **Journal of Pension Economics and Finance**, v. 1, n. 2, p. 111-130, 2002.

BROWN, R. L. Designing a social security pension system. **International Social Security Review**, v. 61, n. 1, p. 61-79, 2008.

BROWN, R. L. Social Security: Regressive or Progressive? **North American Actuarial Journal**, v. 2, n. 2, p. 27–28, 1998.

COILE, C.; DIAMOND, P.; GRUBER, J.; JOUSTEN, A. Delays in claiming social security benefits. **Journal of Public Economics**, v. 84, n. 3, p. 357–385, 2002.

DELGADO, G. C.; QUERINO A. C., RANGEL, L. STIVALI, M. **Avaliação de Resultados da Lei do Fator Previdenciário (1999-2004)**. Texto para discussão Nº 1161, Ipea, 2006.

DIAMOND, P. **Reforming public pensions in the US and the UK.** Economic Journal, v. 116, n. 509, 2006.

FISHER, W. H.; KEUSCHNIGG, C. Pension reform and labor market incentives. **Journal of Population Economics**, v. 23, n. 2, p. 769-803, 2010.

FORTEZA, A.; OURENS, G. Redistribution, insurance and incentives to work in Latin American pension programs. **Journal of Pension Economics and Finance**, p 1-28, 2012.

FORTEZA, A.; OURENS, G. How much do Latin American pension programs promise to pay back? **SP Discussion Paper,** n. 0927, World Bank, 2009.

GIAMBIAGI, F; AFONSO, L. E. Cálculo da alíquota de contribuição previdenciária atuarialmente equilibrada: uma aplicação ao caso brasileiro. **Revista Brasileira de Economia**, v. 63, n. 2, p. 153-179, 2009.

GUSTMAN, A. L.; STEINMEIER, T. L. How effective is redistribution under the social security benefit formula? **Journal of Public Economics**, v. 82, n. 1, p. 1–28, 2001. Disponível em: <http://linkinghub.elsevier.com/retrieve/pii/S0047272700001535>..

GUSTMAN, A. L.; STEINMEIER, T. L.; TABATABAI, N. Redistribution under the Social Security benefit formula at the individual and household levels, 1992 and 2004. **Journal of Pension Economics and Finance**, v. 12, n. 01, p. 1–27, 2012. Disponível em: <http://www.journals.cambridge.org/abstract_S1474747212000108>. Acesso em: 4/7/2013.

HASSLER, J.; LINDBECK, A. Optimal actuarial fairness in pension systems: a note. **Economics Letters**, v. 55, n. 2, p. 251-255, 1996.

HOLZMANN, R. Toward a coordinated pension system in Europe: rationale and potential structure. In: HOLZMANN, R.; PALMER, E. (Ed.) **Pension reform:** Issues and prospects for non-financial defined contribution (NDC) schemes. The World Bank: Washington, D.C., 2006, cap. 3, p. 35-75.

KAHN, J. A. Social security, liquidity, and early retirement. **Journal of Public Economics**, v. 35, n. 1, p. 97-117, 1988.

LEIMER, D. R. **Lifetime redistribution under social security: a literature synopsis**. Social Security Bulletin, v. 62, n. 2, p. 1-9, 1999.

LIEBMAN, J. B., LUTTMER, E. F.P.; SEIF, D. G. Labor supply responses to marginal Social Security benefits: evidence from discontinuities. **Journal of Public Economics**, v. 93, n. 11-12, p. 1208-1223, 2009.

MPS. Boletim Estatístico da Previdência Social, v. 16, n. 2, 2011.

MPS. TABLE de Contribuição Mensal. Available in: <http://www.mps.gov.br /conteudoDinamico.php?id=313>. Access in 17 apr. 2012.

QUEISSER, M; WHITEHOUSE, E. R. **Neutral or fair: actuarial concepts and pension-system design**. OECD Social, Employment and Migration Working Papers n. 40, 2006.

REZNIK, G. L.; WEAVER, D. A.; BIGGS, A. G. **Social security and marginal returns to work near retirement**. Social Security Issue Paper n. 2009-02, 2009.

SHESHINSKI, E. A model of social security and retirement decision. **Journal of Public Economics**, v. 10, n. 3, p. 337-360, 1978.

SCHRÖDER, C. Profitability of pension contributions – evidence from real-life employment biographies. **Journal of Pension Economics and Finance**, v. 11, n. 3, p. 311-336, 2012.

SHOVEN, J. B.; SLAVOV, S. N. **The decision to delay social security benefits: theory and evidence.** NBER Working Paper Nº 17866, February, 2012a.

SHOVEN, J. B.; SLAVOV, S. N. **When does it pay to delay social security? The impact of mortality, interest rates, and program rules.** NBER Working Paper Nº 18210, July, 2012b.