Economia Aplicada, v. 21, n. 3, 2017, pp. 417-435

MACROECONOMIC AND GENERATIONAL IMPACTS OF FISCAL DEVALUATION: AN APPLICATION FOR THE BRAZILIAN CASE *

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Resumo

A desvalorização fiscal normalmente envolve a redução das contribuições para a seguridade social sobre a folha de pagamento com o aumento do imposto sobre o consumo. Este estudo avalia o impacto da desvalorização fiscal no Brasil sobre o consumo, capital, produção e distribuição de renda entre gerações. Para isso, usamos um modelo dinâmico de equilíbrio geral com gerações sobrepostas, expectativa de vida finita, risco de morte e seguridade social. Os resultados sugerem que a desvalorização fiscal provocou resultados positivos, mas modestos, sobre o produto, capital e consumo a longo prazo, sem grandes sacrifícios para a economia no seu caminho de transição.

Palavras-chave: Modelo dinâmico de equilíbrio geral; Gerações sobrepostas; Desvalorização fiscal.

Abstract

Tax devaluation typically involves the reduction of social security contributions on the payroll with the increase of tax on consumption. This study evaluates the impact of fiscal devaluation in Brazil on consumption, capital, output and income distribution between generations. It uses a dynamic general equilibrium model with overlapping generations, finite life spans, risk of death and social security. The results suggest that the fiscal devaluation causes positive, yet modest, impact on product, capital and long-term consumption without major sacrifices for the economy in its transition path.

Keywords: Dynamic general equilibrium model; Overlapping generations; Fiscal devaluation.

JEL classification: E62, C68, H20

DOI: http://dx.doi.org/10.11606/1413-8050/ea113743

* Article awarded the 2nd place in the category Effects of Fiscal and Tax Policies on Competitiveness, the CNI Economics Award 2015

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Recebido em 11 de agosto de 2016 . Aceito em 15 de fevereiro de 2017.

1 Introduction

Taxation is one of the concerns in both national and international discussions of economic policy. The burden or exemption of a certain activity or personal income reflects directly in the agents' decisions, and thus in national growth. On the other hand, the tax system of a country is the government's main source of collection, thereby achieving the maintenance of basic services to society.

Hence, changes in taxation have a significant effect on economic activity and the distribution of resources within society. That is why tax reforms end up surrounded by long and often inconclusive legislative debates.

In Brazil, the major reforms were put aside and the recent strategy has been dedicated to proposing specific changes to the Brazilian tax system. The current proposals for change of the ICMS and PIS/Cofins fall under this context.

However, the changes are not limited to these two taxes. More recently, several countries, especially in Europe, have been studying ways to increase the competitiveness of their economies through changes in taxes. This is the main motivation for the proposed fiscal devaluation.

A fiscal devaluation occurs by the exchange of tax on labor (particularly social security contributions) and its replacement by the tax on consumption. Consequently, the economy gains in competitiveness, mainly because exports begin to incorporate fewer taxes (by reducing the tax on labor factor). Furthermore, imports will be taxed equivalently to domestic products (by increasing the tax on consumption).

Therefore, the main objective of this paper is to simulate the impact of fiscal devaluation on the Brazilian economy, especially its long-term effects on capital formation, economic growth, competitiveness and intergenerational equity.

For this purpose, we use a dynamic general equilibrium model with overlapping generations with finite life spans, risk of death and social security. This model captures the intergenerational effects of tax changes. In addition, it provides more analytical rigor related to the real economy data.

Beyond this introduction, the next section reviews the literature of fiscal devaluation. The third section describes the theoretical model, and subsequent parts present the model solution, calibration, simulations and the main results, respectively. Finally, the last section presents the final remarks.

2 Fiscal devaluation as an economic recovery instrument

Tax depreciation is a tax instrument that can be useful as a stimulus for the national economy. As previously mentioned, tax depreciation typically involves the reduction of social security contributions on the payroll and the increase in value plus tax. This change can be neutral or not.

With the international crisis of 2008, many countries of the European Monetary Zone began studying the possibility of promoting fiscal devaluation as a way to enhance the competitiveness of companies and stimulate job creation and economic growth. The underlying hope is that lower labor costs due to the tax reduction on social security, for example, will increase the demand for labor and reduce unemployment.

The Bank of Portugal (2011) issued a report demonstrating the effects of fiscal devaluation on aggregate variables of the economy. Using a dynamic stochastic general equilibrium model (DSGE - Dynamic Stochastic General Equilibrium) called PERSON, a cut in social security conversely contributions and subsequent increasein VAT was simulated. The long-term results have provided an increase in GDP (0.6%), worked hours (0.6%) and private investment (0.49%)[1].

Fantini (2006) presented some results using the HERMES model (Belgium) from a 0.5% cut on the social contribution of employers. The results indicated an increase in GDP by 0.12% and employment by 0.02%. In comparison, the author developed the QUEST model for 15 selected EU countries and simulated a fiscal devaluation, reducing the tax on labor by 1 percentage point of GDP and increasing the tax on consumption in the same magnitude. The results showed an increase, in the long run, of 0.88% in employment and of 0.72% in GDP (benefits not indexed to consumer prices). If the benefits are indexed to consumer prices, we observe an increase of 0.43% and 0.54% on GDP and employment, respectively.

Boscá et al. (2013) presented the REMS, which is a dynamic general equilibrium model for a small open economy that was calibrated for the Spanish economy. The model is primarily intended to serve as a simulation tool where the focus is on the economic impacts of alternative fiscal policies. The tax depreciation proposed in the research was a 3.5% cut on the contribution rate for social security and a 2.0% increase in the consumption tax rate. The balance result to GDP in the long run was 0.55% and 0.58% on employment.

In Brazil, the government has promoted the elimination of employers' social security contributions on payroll and the creation of a new contribution on company revenues at rates of 1% or 2%, respectively. The measure was not applied to the whole economy and remains valid only for a set of defined sectors in several legal instruments adopted since 2011[2].

In the national literature, various studies on the economic impact of tax changes have already been done. This is the case of Araújo & Ferreira (1999), who conducted research on the allocative effects and the impacts on welfare that tax reforms could cause in the Brazilian economy, using a neoclassical model. The results pointed to long-term gains, of 7% for product, and above 3% for welfare.

In addition, using neoclassical models, Paes (2004) and Paes & Bugarin (2006) studied the distributive and macroeconomic impacts of two tax reforms in the short and long term. They found that these proposals increased production, consumption, working hours, and capital with gains in aggregate welfare.

Another segment of the literature addresses the issue of tax reform with overlapping generations (OLG) models. Fochezatto & Salami (2009) analyzed

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[1]International institutions and many central banks have developed models D (S) GE for their countries. For example, QUEST III for the EU (Ratto et al., 2009), the BEQM for the United Kingdom (Harrison et al., 2005), the SIGMA model for the USA (Erceg et al., 2006), the TOTEM for Canada (Murchison et al., 2004), AINO for Finland (Kilponen et al., 2004), performed by Smets e Wouters models (2003) for the EMU. Two models in the line of REMS for the Spanish economy are BEMOD and MEDEA, respectively developed by Andrés et al. (2006) and Burriel et al. (2010) (Boscá et al. 2013).

[2]Provisional Measures No. 540 (2011); 563 (2012); 582 (2012); 610 (2013) and more recently Law Project No. 863 (2015).

the long-term economic effects of different tax options using an intertemporal general equilibrium model with overlapping generations. Cavalcanti & Silva (2009) and Cavalcanti & Silva (2010) presented a dynamic general equilibrium model proposing tax exemption simulations in the productive sector. These papers innovate in the literature by taking into account the uncertainty about life span and cost of capital adjustment. In the 2009 research, the authors focused on relieving only labor factor. Whereas, in 2010, they advanced in relation to the previous research by comparing the exemption measures of labor factor with capital factor, both offered by increases on consumption. The results in both studies showed capital and product increases, but, with greater intensity on capital exemption when compared to labor exemption. Both policies generated welfare losses for the older generations existing at the time of the tax reform and welfare benefits for future generations.

Silva et al. (2014) analyzed the exemption of the payroll tax with a neoclassical model. Positive effects were found only if the change involved tax breaks. With neutral tax changes, there were no positive impacts of changing the basis of social security contribution from payroll to the company's revenues

This paper contributes to the literature by making simulations of fiscal devaluation in Brazil, which has not yet been done by national studies. Also, it innovates in the use of the OLG model to perform such simulations, which will not only allow an aggregate analysis, but also the impact of the change between generations. This last analysis is important since tax depreciation causes changes in social security contributions.

3 The theoretical model

In this section, we will present a dynamic general equilibrium model grounded in the seminal work of Auerbach & Kotlikoff (1987). For this purpose, the economy will be divided in three sectors: i) household sector, ii) production sector and iii) government sector. It is important to mention that in this model there is no inheritance left to the households. We modified the Auerbach & Kotlikoff (1987) model by incorporating some features appropriate for the Brazilian economy. One of them was inserting uncertainty about the life span of each household (Jokish & Kotlikoff 2007). Other improvements have been made based on Barreto (1997), Arrau (1990), Cavalcanti & Silva (2010) and Ellery & Bugarin (2003). Social security was modeled separately from the government, based on Fochezatto & Salami (2009).

3.1 Households

The sector called households entails 55 overlapping generations of adults. Every year, a generation dies and another one is born. It is useful to think of these "new" adults as being 21 years of age with an expected age of death of 75 years. The assumption is that individuals start working at 21 years of age (when $j = 1$, where j is the generation), retire at 65 years ($j = 45$) and die at 75 years of age ($j = 55$). As with other aspects of uncertainty encountered in the real world, the uncertainty of life span was introduced by the mortality rate of each household. This rate is the conditional probability of each generation living another year.

For each household, we assumed preferences represented by a utility function with current and future values of consumption and leisure. We can represent the intertemporal utility function as follows:

$$U_t = \frac{1}{(1-1/\gamma)}\sum_{j=1}^{55}(1+\beta)^{-(t-1)}p_j u_{j,t}^{(1-1/\gamma)} \tag{1}$$

Where:

$$u_{j,t}(c_{j,t}, l_{j,t}) = (c_{j,t}^{1-1/\rho} + \alpha l_{j,t}^{1-1/\rho})^{1/(1-1/\rho)} \tag{2}$$

In Equation (1), γ is the intertemporal elasticity of substitution[3], β is the discount rate or the preference for the present[4], p_j is the probability of survival of the individual of the j household. In Equation (2), $c_{j,t}$ and $l_{j,t}$ represent consumption and leisure with age j at time t. The parameter ρ is the intratemporal elasticity of substitution between consumption and leisure, and α determines the intensity of preferences of households for leisure in relation to consumption.

Households maximize their intertemporal utility based on their income expectations throughout the life cycle, as follows:

$$\underset{(c_{j,t}, l_{j,t})}{MAX\ U_t} = \frac{1}{(1-1/\gamma)}\sum_{j=1}^{55}(1+\beta)^{-(t-1)}p_j u_{j,t}^{(1-1/\gamma)} \tag{3}$$

Subject to:

$$\begin{aligned}&\sum_{j=1}^{45}\prod_{m=1}^{t}\frac{W_t e_j(1-l_{j,t})(1-\tau_{lt}-\tau_{st})}{[1+r_m(1-\tau_{kt})]} + \sum_{j=46}^{55}\prod_{m=46}^{t}\frac{b_t}{[1+r_m(1-\tau_{kt})]} + Tr_t \\ &\geq \sum_{j=1}^{55}\prod_{m=1}^{t}\frac{(1+\tau_{ct})c_{j,t}}{[1+r_m(1-\tau_{kt})]};\ l_t < 1, \forall t = 1,\ldots,45;\ l_t = 1, \forall t = 46,\ldots,55\end{aligned} \tag{4}$$

In Equation (4), which represents the budget constraint, the present value of consumption throughout the life cycle is less than or equal to the present value of the individuals' income during the finite life period. Where W_t is the salary in the year t, $(1-l_{j,t})$ is the hours worked and e_j is an exogenous adjustment factor to allow for the fact that households can earn more or less per hour due to differences in skill levels between households of different ages. Vector e_j can be considered as a proxy for the "human capital". The tax rates are the following: τ_{lt} – tax rate on labor income, τ_{kt} – rate on income from capital, τ_{ct} – tax rate on consumption and τ_{st} – rate of contributions to social security, and Tr_t is the government transfers.

For the expression, r_t would be the real interest rate and b_t represents transfers to households from social security. According to law number 9.876/1999, individuals retired by contribution time and age will have their benefit

[3]This parameter shows the response capacity of households to changes in incentives to save.

[4]The longer the β, the individual prefers more present consumption over future consumption.

from wages according to a simple arithmetic average of the highest contribution salaries corresponding to eighty percent (0.8) of all the contributory period, fixed monthly and multiplied by the social security factor. With this information, the social security factor can be written as:

$$f = \frac{Tcxa}{Es} x[1 + \frac{(Id + Tcxa)}{100}] \tag{5}$$

Where: f = social security factor; Es = survival expectancy at retirement; Tc = contribution time until the time of retirement; Id = age at retirement; a = adjustment factor on the contribution rate.

$$b_t = 0.8 \sum_{j=1}^{45} (\frac{W_{t-j} e_j (1 - l_{j,t-j})}{45}) f \tag{6}$$

From the moment that retirement takes place ($j = 46, \ldots, 55$), the worked hours no longer exist, and we are left only with $l_j = 1$.

Finally, solving $j = 1, \ldots, 4$, maximizing the utility function subject to budget constraint, we obtain the temporary paths and intratemporal relation of consumption and leisure, Equations (7), (8) and (9), respectively:

$$\begin{aligned} c_{j,t} = c_{j-1,t-1} (\frac{(1+\beta)^{t-2}}{(1+\beta)^{t-1}})^{\gamma} ([1 + r_t(1 - \tau_{kt})])^{\gamma} \\ (\frac{p_j}{p_{j-1}})^{\gamma} (\frac{1 + \tau_{ct-1}}{1 + \tau_{ct}})^{\gamma} (\frac{1 + \alpha^{\rho} (w^*_{j-1,t-1})^{(1-\rho)}}{1 + \alpha^{\rho} (w^*_{j,t})^{(1-\rho)}})^{\frac{\rho-\gamma}{\rho-1}} \end{aligned} \tag{7}$$

$$\begin{aligned} l_{j,t} = l_{j-1,t-1} (\frac{(1+\beta)^{t-2}}{(1+\beta)^{t-1}})^{\gamma} ([1 + r_t(1 - \tau_{kt})])^{\gamma} (\frac{p_j}{p_{j-1}})^{\gamma} \\ (\frac{1 + \tau_{ct-1}}{1 + \tau_{ct}})^{\gamma} (\frac{1 + \alpha^{1+\rho} (w^*_{j-1,t-1})^{(1-\rho)}}{1 + \alpha^{1+\rho} (w^*_{j,t})^{(1-\rho)}})^{\frac{\rho-\gamma}{\rho-1}} (\frac{w^*_{j-1,t-1}}{w^*_{j,t}})^{\rho} \end{aligned} \tag{8}$$

$$l_{j,t} = c_{j,t} \alpha^{\rho} w^{*(-\rho)}_{j,t} \tag{9}$$

Where,

$$w^*_{j,t} = (\frac{W_t e_j (1 - \tau_{lt} - \tau_{st}) + \mu_{j,t}}{(1 + \tau_{ct})}) \tag{10}$$

The parameter $\mu_{j,t}$ would be the shadow wage of household j in year t, which is equal to zero if the individual offers any amount of labor, and nonzero if he decides to not work in year t. $\frac{p_{j-1,t-1}}{p_{j,t}}$ is the conditional probability of a household in generation j living over a unit of time.

For retirees that correspond to $j = 46$ age, ..., 55, the leisure path is unitary; so, from the maximization process of the utility function subject to budget constraint, we have the following consumption equation:

$$\left(\frac{c_{j,t}}{c_{j-1,t-1}}\right)^{-1/\rho}\left(\frac{c_{j,t}^{(1-1/\rho)}+\alpha l_{j,t}{}^{(1-1/\rho)}}{c_{j-1,t-1}^{(1-1/\rho)}+\alpha l_{j-1,t-1}{}^{(1-1/\rho)}}\right)^{\frac{(1/\rho)-(1/\gamma)}{1-1/\rho}}$$
$$=\left(\frac{(1+\beta)^{-(t-2)}}{[1+r_t(1-\tau_{kt})](1+\beta)^{-(t-1)}}\right)\left(\frac{p_{j-1,t-1}}{p_{j,t}}\right)\left(\frac{1+\tau_{ct}}{1+\tau_{ct-1}}\right) \tag{11}$$

3.2 Production

The economy has a competitive firm representative. The production function has Cobb – Douglas technology. The labor differs according to its level of efficiency (e_j). In other words, all forms of labor are perfect substitutes, but people of different ages provide different amounts of labor.

$$Y_t = F(K_t, L_t) = A_t(K_t^{\theta} L_t^{1-\theta}) \tag{12}$$

Where Y_t is the aggregate output, K_t and L_t represent capital and aggregate labor, respectively. The term θ is the participation of capital income in the output. Finally, A_t is a scale factor which represents the total factor productivity.

Firms maximize profits intertemporally restricted to production costs, so that:

$$\Pi_t = Y_t - W_t L_t - (r_t + \delta)K_t \tag{13}$$

δ is the capital depreciation rate. Solving the maximization problem of firms, we have:

$$W_t = (1-\theta)A_t\left(\frac{K_t}{Lt}\right)^{\theta} \tag{14}$$

$$r_t = \theta A_t\left(\frac{K_t}{Lt}\right)^{(\theta-1)} - \delta \tag{15}$$

Where W_t and r_t represent wages and the interest rate at time t.

3.3 Government

The equation that describes the behavior of the government includes a social security system that is independent of the government. This sector collects taxes on payroll and performs benefit payments. Thus, government consumption with social security and transfers can be written as the following (16):

$$G_t = T_t - S_t^B - Tr_t \tag{16}$$

G_t is the government purchases of goods and services, S_t^B represents the benefits of social security and Tr_t is the government transfers to the households. For tax collection T_t, we have:

$$T_t = \sum_{j-1}^{45} N_j \tau_{lt} W_t e_j (1 - l_{j,t}) + \sum_{j=1}^{55} N_j c_{j,t} \tau_{ct} + \tau_{kt}(r_t + \delta)K_t + S_t^A \tag{17}$$

C_t is the aggregate consumption, S_t^A is the collection of social security, N_j is the population of age j for the year 2009.

3.4 Social Security

In Brazil, social security uses the simple distribution system (PAYG), in which the benefits received from age 65 (in the model equivalent to $j = 45$) ranging up to 75 years of age (in the model $j = 55$) are measured by average of the individual's contribution time represented by the Equation (6), as described.

Therefore, the total annual expenditure on social welfare can be represented by the following equation:

$$S_t^B = \sum_{j=46}^{55} N_j b_t \tag{18}$$

The annual revenue of social security comes from employees' remuneration:

$$S_t^A = \sum_{j=1}^{45} N_j W_t e_j (1 - l_{j,t}) \tau_{st} \tag{19}$$

3.5 Welfare

To calculate the variation on the households' welfare according to changes in tax policy, we will use the consumption equivalent variation, which is the amount of leisure and consumption that should be available to consumers in order to maintain the same level of utility they had before the tax policy. This variation of gain or loss portion arises from the solution at d in the following equation:

$$\begin{gathered}(1+d_j)^{\frac{1}{1-1/\gamma}} U_{j,0} = \frac{1}{1-1/\gamma} \sum_{j=1}^{55} (1+\beta)^{-(t-1)} p_j \\ ((c_{j,t}(1+d_j)^{(1-1/\rho)} + \alpha l_{j,t}(1+d_j)^{(1-1/\rho)})^{\frac{1}{1-1/\rho}})^{1-1/\gamma}\end{gathered} \tag{20}$$

$U_{j,0}$ is the utility levels of steady state, $c_{j,t}$ and $l_{j,t}$ are the consumption and leisure of family j at time t under the new policy. Having the utility $(u_{j,t})$ after the tax policy, the equivalent variation as welfare measure can be calculated as:

$$d_j = (\frac{u_{j,t}}{u_j})^{\frac{1}{1-1/\gamma}} - 1 \tag{21}$$

3.6 Market Equilibrium

The equilibrium conditions must be satisfied for each of the markets, namely: goods, labor and capital. For the labor market, the condition of supply (right-hand side) and demand of skilled labor (left-hand side) is satisfied by the following equation:

$$L_t = \sum_{j=1}^{45} N_j e_j (1 - l_{j,t}) \tag{22}$$

The balance in the capital markets is given by:

$$K_{t+1} = Y_t + (1-\delta)K_t - G_t - C_t \tag{23}$$

The condition of supply and aggregate demand is represented by the following equation:

$$Y_t = C_t + I_t + G_t \tag{24}$$

Where,

$$I_t = K_{t+1} - (1-\delta)K_t \tag{25}$$

$$C_t = \sum_{j=1}^{55} c_{j,t} N_j \tag{26}$$

4 Solution Model

For the solution of the balance path of the economy, we have used a Broyden (1965) algorithm to numerically solve the set of dynamic nonlinear equations that compose the model (Equations (4) to (26)). The solution provides the path of the economy after the change in tax policy. The calibration of the model, the tax simulations proposed and the results will be presented in the following sections[5].

5 Calibration

The calibration of the model involves finding values for the parameters and variables consistent with data from the real economy. In this paper, we use the last available data from the National Accounts, released by IBGE (Brazilian Institute of Economics and Statistics), which is for the year 2009, and also the Paes & Bugarin (2006b) research. Therefore, the year 2009 is considered the steady-state balance in the model 2009. We considered the balance product for this year as a numeric. Thus, Table 1 shows the values of the model parameters. The intertemporal elasticity of substitution (γ) and the preference for leisure in the utility function (α) were obtained from the works by Cavalcanti & Silva (2010) and Ferreira (2004). The remaining parameters were calculated endogenously from the steady state equilibrium equations.

Table 2 illustrates data from National Accounts.

To compute the model tax rates, we used the study done annually by Brazil's RFB (Secretariat of Federal Revenue of Brazil), which is consolidated in the Tax Burden in Brazil RFB (2009). With this data and the National Accounts data (2009), we have calculated the tax rates on capital income (τ_k), tax on labor income (τ_l), tax on social security (τ_s) and the consumption tax (τ_c). Table 3 illustrates the amount of tax revenues in absolute values and in proportion to GDP.

IOF – which is a tax levied on financial operations, has mainly two tax bases – personal credit (consumption) and interest on financial investments and foreign exchange operations (capital income). Since the major part of

[5] In this paper, we used Python 2.7 and 3.4 programming language. We developed the algorithm for the numerical solution of the model using PythonXY 2.7.9 scientific platform.

Table 1: Parameters of the model

Description	Parameters	Value
Intertemporal elasticity of substitution	γ	0.700*
Intratemporal elasticity of substitution	ρ	1.134
Preference for leisure in the utility function	α	0.250**
Preference for the presente	β	0.025
Total factor productivity	A	1.058
Capital participation in the production function	θ	0.391
Capital depreciation rate	δ	0.048
$e^{a+b_j+c_j^2}$	e_j	$a = -0.944100$
		$b = \ \ 0.015680$
		$c = -0.000671$

Source: Authors elaboration.
* Cavalcanti & Silva (2010).
** Ferreira (2004)

Table 2: Economic Aggregates (2009)

	Brazil in 2009 as % of GDP	Model
Consumption	60.870	60.870
Government Consumption	21.120	21.120
Investment		370.110
Selic interest rate	17.990	17.990
Real interest rate	5.710**	5.710
Wages rate	60.860	60.860
Government revenue	32.470	32.470
Social Security revenues	7.060	7.060
Expenditure on Social Security	6.075	6.074

Source: IBGE (2011), IPEADATA (2009) and authors elaboration.
* Selic interest rate - average annual 2009
** This result is the difference between IPCA 2009 (4.31) and the average annual Selic rate for 2009.

revenue comes from financial instruments, IOF was considered as a tax on capital income.

To calculate the tax rate on capital income (τ_k), we used the collection of taxes for the year 2009: IRPJ (2.49% of GDP), CSLL, IPTU, ITR, ITBI, IPVA, IOF:

$$\tau_k = \frac{(IRPJ + CSLL + IPTU + ITR + ITBI + IPVA + IOF)}{\theta} \tag{27}$$

For the tax rate on labor income (τ_l), we used the values of the following tax collection: IRPF (0.45%), IRRF (3.18%), FGTS, S System, Education Wage. We named this amount $Arrec_\tau$.

$$\tau_l = \frac{Arrec_{\tau_l}}{(1-\theta)} \tag{28}$$

PREV is the federal, state and municipal social security collection. The rate of social security (τ_s) is the relationship between general social security collection (PREV), civil servants (CPSS), and the remuneration of the labor $(1-\theta)$, in order to obtain the rate of this tax:

$$\tau_s = \frac{PREV + CPSS}{(1-\theta)} \tag{29}$$

Table 3: Tax burden in Brazil (2009)

Tax	R$ millions	% GDP	Incidence	Model
ICMS	224,027.74	7.13	Consumption	YES
Income tax	192,315.02	6.12	Capital / Labor	YES
Social Security	182,008.44	5.79	Social Security	YES
Cofins	115,995.84	3.69	Consumption	YES
FGTS	54,725.95	1.74	Labor	YES
CSLL	43,583.09	1.39	Capital	YES
IPI	27,767.44	0.88	Consumption	YES
PIS	25,816.81	0.82	Consumption	YES
ISS	22,354.48	0,71	Consumption	YES
IPVA	17,567.21	0.56	Capital	YES
IOF	19,224.74	0.61	Capital	YES
Cont. S. S. Serv. Pub. (CPSS)	18,510.84	0.59	Social Security	YES
Prev. State	17,127.42	0.54	Social Security	YES
Imp. Trade	15,895.41	0.51	Consumption	YES
IPTU	12,235.12	0.39	Capital	YES
Education Wage	9,685.19	0.31	Labor	YES
Other state taxes	1,795.29	0.06		NO
S System	8,609.23	0.27	Labor	YES
State rates	7,938.36	0.25		NO
PASEP	5,163.25	0.16	Consumption	YES
CIDE fuels	4,911.41	0,16		NO
Municipal social security	4,246.11	0.14	Social Security	YES
ITBI	3,746.58	0,12	Capital	YES
Municipal taxes	3,285.89	0.10		NO
Other social cont.	2,513.24	0.08		NO
ITCD	1,590.71	0.05		NO
Cont. military pensions	1,681.26	0.05		NO
Merchant navy quota part	1,510.71	0.05		NO
Other trib. and rates	8,091.30	0.26		NO
Cide shipments	1,148.81	0.04		NO
Union cont. quota part	314.63	0.01		NO
Other economic cont	44.15	0.00		NO
Prov. cont. of fin. transactions		0.00		NO
TOTAL	1,055,407.07	33.58		32.47

Source: RFB (2009).

Finally, the last rate used in the model is the tax rate on consumption (τ_c). This rate is found by relating the collection on consumption: IPI, ICMS, ISS, Imp. Trade, COFINS, PIS and PASEP, and the proportion of household consumption in relation to the national product (C/Y = 60.87%).

$$\tau_c = \frac{IPI + ICMS + ISS + II + COFINS + PIS + PASEP}{C/Y} \tag{30}$$

Table 4 summarizes the values found in tax rates.

Table 4: Tax rates

	Description	Value
τ_k	Tax rate on capital income	14.200%
τ_l	Tax rate on labor income	0.977%
τ_s	Tax rate on social security	11.590%
τ_c	Tax rate on consumption	22.830%

Source: Authors elaboration.

6 Simulation

For the first simulation, we will reduce in 1% of GDP the revenue for social security and increase in 1% of GDP the collection of consumption. In simulations 2 and 3, we propose to reduce 2.0% and 2.5% of GDP on social security revenue and increase this proportion for revenues on consumption.

In the next section, we will present the results of simulations for the product, aggregate consumption, intratemporal income distribution, capital stock and welfare.

Table 5: Fiscal devaluation

	Devaluation (simul-1: 1.0%)	Devaluation (simul-2: 2.0%)	Devaluation (simul-3: 2.5%)
τ_s	0.0995	0.0831	0.0749
τ_c	0.2447	0.2611	0.2693

Source: Authors elaboration.

7 Results

The results for the three simulations proposed are presented by listing the main variables of aggregate consumption, capital stock, product and welfare. We considered 100 periods for the long term. The following table presents the main macroeconomic results of each of the simulations performed.

The results suggest gains for the main macroeconomic variables, especially for household consumption. For the 1.0% simulation, household consumption (% GDP) has grown to 60.91%, against 60.95% for the 2.0% simulation and 60.96% for the 2.5% simulation. This result is partly explained by the increase of wages (sim-1: 0.0158% sim-2: 0.0313% and sim-3: 0.0390% - var.% steady state).

With fiscal devaluation policy, it is expected that the labor will increase in the long run, and this was observed in all simulations. It increased by 0.161% for sim-1, 0.3162% for sim-2 and 0.3923% for sim-3. In the long run, the economy also accumulated more capital: it increased 0.0116% (sim-1), 0.0270% (sim-2) and 0.0359% (sim-3), respectively. The explanation for this capital increase is product growth. The product increased by 0.102% (sim-1), 0.202% (sim-2) and 0.252% (sim-3). But capital increase was lower than output, since firms prefer to use more labor and less capital. As a result, the ratio capital/output falls in the three simulations.

Regarding social security expenditure, it increased by 0.1388%, 0.2738% and 0.3397% for simulations 1, 2 and 3, respectively. This is due to the workers' wage increases in the past 45 years, since the benefits of the current period depend on the weighted average of the wages earned during the period in which the retirees were still working. On the other hand, with fiscal devaluation, the social security collection (var. % steady state) fell around 14.07% (sim-1), 28.18% (sim-2) and 32.25% (sim-3). Given the significant decreases, social security can only honor its social security commitments in the long run if there is an increase in transfers from the National Treasury, which is possible by the increase in consumption collection.

The government tax collection remained neutral in the long run, with the reduction in the tax on social security fully offset by the increase in consumption tax for the three simulations.

Table 6: Long-term macroeconomic effects

	Steady state	Devaluation 1.0%	Devaluation 2.0%	Devaluation 2.5%
		Taxes (%GDP)		
Tax on consumption	22.83	24.47	26.11	16.93
Cont. on Social Security	11.59	9.95	8.31	7.49
Tax on Labor	9.77	9.77	9.77	9.77
Tax on Capital	14.20	14.20	14.20	14.20
		Macroeconomic variables		
		var. %SS - %GDP**	var. %SS - %GDP**	var. %SS - %GDP**
Consumption	60.87	0.1667-60.910	0.3270-60.950	0.4048-60.960
Government Cons.	21.12	0.0000-21.120	0.0000-21.120	0.0000-21.120
Investments	17.99	0.0114-17,974	0.0269-17,958	0.0358-17,951
Capital	370.00*	0.0116-369,660	0.0270-369,350	0.0359-369,200
Labor	0.3928	0.3934***	0.3942***	0.3943***
Product	10.00	1.0010****	1.0020****	1.0030****
Interest rate	5.71	5.7200*****	5.7290	5.7330*****
Wages	60.86	0.0158-60.8070	0.0313-60.7560	0.0390-60.7300
Soc. Sec. Expenditure	6.07	0.1388-6.0720	0.2738-6.0740	0.3397-6.0750
Soc. Sec. Collection	7.06	(14.07)-6.0600	(28.18)-5.0600	(35.25)-4.5600
Tax Collection	32.47	0.1315-32.4790	0.2630-32.4890	0.3290-32.4950

Source: Authors elaboration.
* Lledo (2001).
** Percentage in relation to steady state and percentage in relation to GDP.
*** In unit of time.
**** Variation over steady state.
***** In percentual.

As for short-term impacts and the transition, Figure 1 summarizes the impact of these reforms along the transition path on GDP, aggregate consumption, capital, labor, allocation, aggregate wages, interest rates and fiscal variables. This figure shows the evolution of these variables in the 100 periods. The evolution of each variable is measured from the percentage change in relation to the initial steady state. Most of the impact of the reform was concentrated in the first years of transition.

Tax reforms resulted in an increase in consumption followed by an increase in the stock of physical capital, an increase in labor supply and an increase in production during the transition between steady states.

The aggregate consumption begins its transition with a slight increase in the first period after the reform, increasing rapidly from the 3rd period through the first forty-four, where it reaches its maximum. After that time, there was a sharp drop, to finally reach the new level of steady state from the period 60, which on average was approximately 0.16% (sim-1), 0.32% (sim-2) and 0.40% (sim-3).

After a fall in the first year, the capital stock gradually increases until it reaches its peak in period 32. Then, a slight decline takes place, which persists until year period 60. From that moment, the economy adjusts itself around its new steady state, greater than the initial steady state, on the average of about 0.04% (sim-1), 0.06% (sim-2) and 0.07% (sim-3).

The capital growth was followed by a continuous wage increase. Despite the decline in the first period, which resulted in part from increased labor, and the reduction in interest rates, wages continued their path of sustainable growth. In order to better understand these results, it is necessary to look at the income and substitution effects.

Since fiscal policy aimed at maintaining tax revenue, the total amount of resources that the tax system extracts from the private sector after the tax change is close to the level drawn before the reform. Therefore, the effects on income, occurring from the proposed reform, result in redistribution between overlapping groups. The policy, however, alters the incidence pattern by modifying the payment of taxes from different groups in the private sector and changing the tax burden on each generation.

For those who are retired, the marginal propensity to consume is higher, and therefore they are fully affected by the increase in consumption tax. Moreover, this generation is not benefited by the reduction in the tax on labor, so the income effect is zero for this group. Based on this argument, the final impact on retirees will be negative. The younger generations, on the other hand, have a marginal propensity to consume less than the pensioners, and also benefit from reduced contributions to social security. Over time, the generations who were young at the beginning of the reform start to increase their share in aggregate consumption. Thus, due to the positive effects on income, they will consume more than they would have consumed before the implementation of tax reform. The result is an increase in aggregate consumption.

The next figure shows the impact of the change on the social security accounts.

As we can see, by time 60, both the expenditure and the social security collection fit to reach the new steady state. While social security expenditure has grown during all the period, social security revenue has dropped sharply during the path to the new steady state. Social security deficit grows strongly with any of the simulations and should be covered by the National Treasury with funds from the increase in revenue of taxes on consumption.

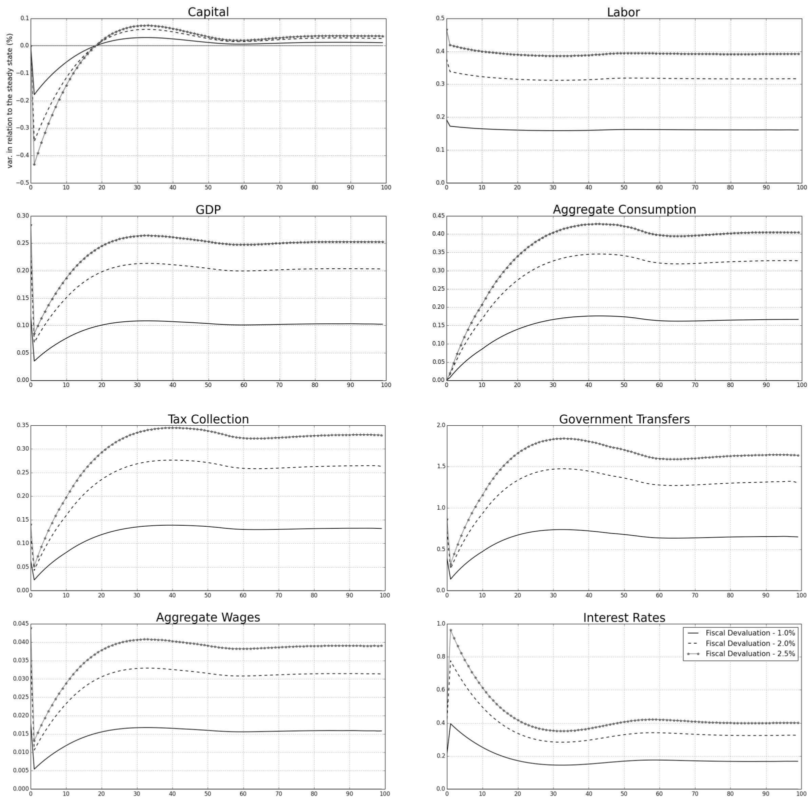
Economic welfare is obtained by the behavior of households born before and after the tax reform. This can be seen in Figure 3.

The horizontal axis shows the generations, for example, in the −54 to −45 range we have the individuals who are retired at the time of the tax reform. Between −1 and −44, we have the households who are in the labor market after the tax change. From generation 0, we find the generations born after the tax change.

We noted, from Figure 3, that for all simulations, retirees lose welfare. The main explanation of this welfare loss is the fact that they do not benefit from the reduction in the tax rate on social security. Moreover, they pay part of the increase in consumption taxation. But, for those who are working, tax reform could be beneficial, since the rate of social security contributions is lower in the three policies. The more distant the worker is from retirement, the more gains he will have. The welfare loss decreases the closer the generation is to the moment of reform. For example: (i) for workers who were born 36 years before the reform: welfare loss of 0.24% (sim-1), 0.47% (sim-2) and 0.58% (sim-3); (ii) for workers who were born 10 years before the reform: welfare gain of 0.09%, 0.17% and 0.21% for sim-1, sim-2 and sim-3, respectively.

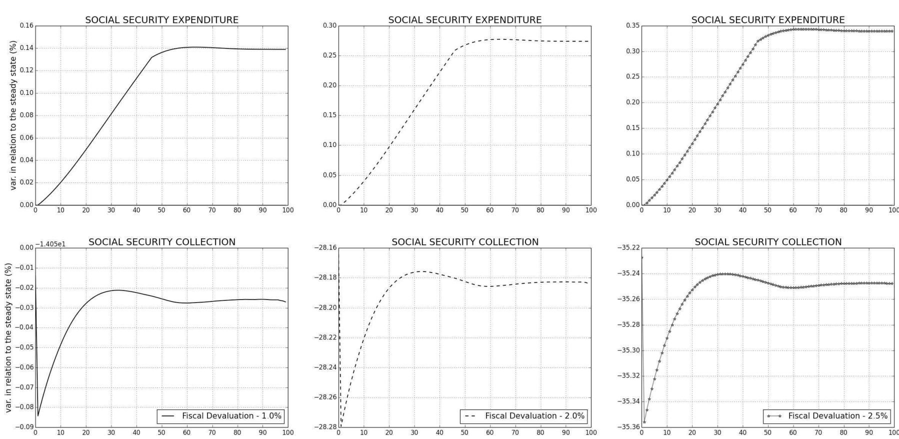
So, our results suggest that the proposed tax reforms described in this paper have modest gains for the macroeconomic variables, in particular aggre-

Figure 1: Transition path for selected variable (var. % steady state)



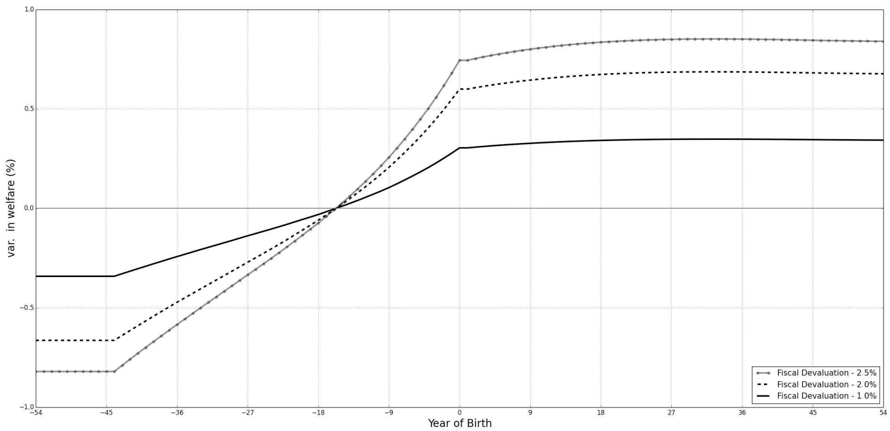
Source: Authors elaboration.

Figure 2: Relationship between social security expenditure and collection (var. % steady state)



Source: Authors elaboration.

Figure 3: Effects on welfare among generations (var% ev.)



Source: Authors elaboration.

gate consumption, capital, labor, product and wages.

Finally, Table 7 compares the results of simulation-1 with other studies that use dynamic general equilibrium models with tax reform proposals.

As shown in Table 7, the model proposed in this work – DGE, in comparison Gauthier (2008) and Klein and Simon (2010), obtained a variation in relation to the steady state on the identical GDP, in the order of 0.1%. The impact on employment in the proposed model was slightly lower than in the other simulations, but with the same sign - positive variation. The simulation of the proposed model also approached Langot et al. (2011) compared the variation around the steady state long term GDP, results near 0.1%.

Table 7: Overview of quantitative studies on the effects of fiscal devaluation. Reduction of Social Security and VAT increase (or consumption tax) of 1% of GDP.

	Short-term effects		Long-term effects[a]	
Research	GDP (%)	Employment (%)	GDP (%)	Employment (%)
Proposed Model - DGE			0.1	0.16
Besson (2007) – DGTPE, complete pass through		0.2		0.00
Gauthier (2008) – uniform ESSC cut			0.1	0.30
Gauthier (2008) – targeted ESSC cut			0.7	1.50
Fève et al. (2009) – model without matching frictions	0.7		0.9	0.80
Fève et al. (2009) – model with matching frictions	0.1	0.2	0.3	0.30
Klein and Simon (2010)	−0.1	0.2	0.1	0.30
Bank of Portugal (2011)	0.2	0.4[b]	0.6	0.60[a]
Langot et al. (2011)			0.1	0.00
EC (2011) – low labour supply elasticity	0.0	0.2	0.4	0.40
EC (2011) – high labour supply elasticity	0.1	0.2	0.7	0.80
Heyer et al. (2012) – basic Case	0.1	0.2	0.3	0.30

Fonte: Koske (2013) and authors elaboration.
Notes: [a] Effect after 5 years for Heyer et al. (2007) and Klein e Simon (2010), after 10 years for Gauthier (2008) and Bank of Portugal (2011), after 30 years for EC (2011), after 40 years for Fève et al. (2009) and after 100 years for Langot et al. (2011). Effect after 150 periods for the proposed model – DGE.
[b] Impact on hours worked since employment effect is not available.

8 Conclusion

This paper studied the fiscal devaluation, an instrument that can be useful in economic policies to boost economic growth through reducing labor taxes and increasing consumption taxes. To evaluate the usefulness of this instrument for Brazil, we developed a dynamic general equilibrium model with overlapping generations, uncertainty and social security imbalance. A revenue neutral simulation was conducted.

The results pointed out to positive, but modest, effects on the economy. Consumption, capital stock, product and worked hours grow, but in a residual form. Given the modest results, fiscal devaluation does not look like an appropriate instrument to introduce in the Brazilian tax system. Other reforms, such as simplifying ICMS and PIS/Cofins, are much more promising to tackle the distortions of the taxation.

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