ÁREA 4 –MACROECONOMIA, ECONOMIA MONETÁRIA E FINANÇAS

TAX COLLECTION EFFICIENCY: AN ALTERNATIVE REVENUE BOOSTER.

Francisco Germano Carvalho Lucio[1]
José Weligton Félix Gomes[2]
Arley Rodrigues Bezerra[3]
Ricardo A. De Castro Pereira[4]

ABSTRACT

Due to the restrictions on economic activities in Brazil caused by the Covid-19 pandemic, the reduction in tax revenue for almost two years in a row with no plan to compensate it has increased the fiscal deficit, aggravating the imbalance of Brazilian public finances. Although efficiency issues in the public sector are widely reported, there is still undeveloped literature concerning efficiency in taxation. Based on that, this paper applies a dynamic computable general equilibrium (CGE) model to measure possible gains from efficiency improvements in tax collection in Brazil. It is calibrated to represent the Brazilian economy. Fiscal policies of reduction in tax rates are simulated, controlling for the total tax revenue to keep at least the same level in the short run. All of the simulated policies would yield positive gains in gross domestic output (GDP) and well-being, as a sustainable way to increase tax revenue. The findings contribute to the public debate and provide some policy implications as feasible alternatives that can be applied to overcome or at least mitigate the fiscal situation of the public finances in Brazil.
Keywords: Efficiency. Public sector. Taxation.
JEL Classification: C68, E62, H21.

RESUMO

Devido às restrições às atividades econômicas no Brasil causadas pela pandemia de Covid-19, a redução da arrecadação tributária por quase dois anos consecutivos sem plano de compensação aumentou o déficit fiscal, agravando o desequilíbrio das finanças públicas brasileiras. Embora questões de eficiência no setor público sejam amplamente estudadas, a literatura sobre eficiência na tributação ainda é pouco explorada. Com base nisso, este artigo aplica um modelo dinâmico de equilíbrio geral computável (CGE) para mensurar possíveis benefícios no ambiente fiscal e macroeconômico a partir de melhorias de eficiência na arrecadação de impostos no Brasil. Adicionalmente, simulou-se políticas fiscais de redução de alíquotas tributárias, controlando-se para que a receita tributária total permaneça inalterado no curto prazo. Todas as políticas simuladas trariam ganhos positivos no produto interno bruto (PIB) e no bem-estar, configurando-se como uma forma sustentável de aumentar a receita tributária. Os resultados contribuem para o debate público ao apresentar algumas políticas como alternativas viáveis que podem ser aplicadas para superar ou pelo menos mitigar a situação fiscal das finanças públicas no Brasil.
Palavras-Chave: Eficiência. Setor público. Tributação.
Classificação JEL: C68, E62, H21.

[1] Federal University of Cariri – UFCA; Av. Tenente Raimundo Rocha, 1639, Bloco M, sala 409. Cidade Universitária. 63048-080. Juazeiro do Norte/CE - Brasil. E-mail: germano.carvalho@ufca.edu.br

[2] Federal University of Ceará – UFC; Department of Economics and Finance - Campus of Sobral. Rua Coronel Estanislau Frota, Centro, 62010560, Sobral- CE - Brasil. E-mail: weligtongomes@gmail.com

[3] Federal Rural University of Pernambuco – UFRPE; Av. Gregório Ferraz Nogueira, José Tomé de Souza Ramos, 56909535, Serra Talhada/PE – Brasil. E-mail: arley.bezerra@ufrpe.br

[4] Ceará Institute for Research and Economic Strategy – IPECE and Federal University of Ceará – CAEN/UFC. Av. da Universidade, 2700. Benfica, 60020181, Fortaleza/CE - Brasil. E-mail: rpereira@caen.ufc.br

1. INTRODUCTION

This paper focuses on efficiency in tax collection. Specifically, it proposes an alternative approach to increase tax revenue and, as a result, reduce or even reverse the current fiscal deficit in the public finances of the central government in Brazil. It emphasizes that there is still negative effects in terms of reduction on tax revenue caused by the restrictions on economic activities as some of the sanitary measures adopted to prevent the spreading of the Covid-19 pandemic. This alternative lies in improving efficiency in tax collection at the country level.

The Brazilian macroeconomic scenario has been characterized in recent years by an intense debate regarding the evolution of the public debt trajectory and, therefore, the management of public spending. The explosive path of the public debt has required solutions to contain the fiscal deficits that started in 2014 after a period of distancing from the so-called tripod of macroeconomic policy, which adopts the primary surplus targets as one of its main pillars.

To contain the accelerated growth in government spending and moderate the evolution of the debt/GDP ratio and reduce the instability generated in the Brazilian economy, the Constitutional Amendment No. 95/2016 was approved instituting a new tax Regime, the so-called Spending Cap fiscal regime, imposing individualized limits on the primary expenses, valid for up to twenty years, although it can be revised in 10 years, that is, in 2026.

This debate has been intensified with the effects of the new coronavirus pandemic. According to a report from the Independent Fiscal Institute (IFI, 2020), the increase in economic activity in the third quarter of 2020 was not enough to bring GDP back to the pre-pandemic level. The collection in October 2020 was driven by the payment of deferred taxes, a fact that should be considered in the analysis as it is not related to the improvement in economic activity. Indeed, the tax collection as a share of the GDP decreased from 33.17% in 2019 to 31.64% in 2020[1], which represents a reduction of 0.87 percentage points (p.p.) of GDP.

In 2021, the gross tax burden of the General Government (Central Government, States and Municipalities) was 33.90% of GDP, which represents an increase of 2.14 p. p. of GDP compared to 2020 (31.76%). The result was influenced by the reversal of tax incentives granted during the Covid-19 pandemic and by economic growth in 2021 based on the resumption of sectors such as commerce and services. Splitting by tier of government, the 2021 gross tax burden of the Central Government grew by 1.53 p.p. of GDP (22.48% compared to 20.95% in 2020)[2].

Regarding public debt, official website of Brazil's Central Bank[3] shows that the General Government Gross Debt, which comprises the Federal Government, social security and state and municipal governments, reached R$5.5 trillion in January 2020, equivalent to 76.1% of GDP. In November of the same year, it reached R$6.5 trillion, equivalent to 88.1% of GDP. This significant leap is due to emergency spending due to the Covid-19 pandemic. In November 2021, it reached 81.1% of GDP (R$7.0 trillion). In May 2022, it reached the amount of R$7.1 trillion, which in this case represents 78.2% of GDP. Nevertheless, it is estimated the continuous growth of the debt/GDP ratio up to 103.4% in 2030 (IFI, 2021).

It is emphasized that the measures applied so far have their potential suppressed due to the rigidity in the structure of Brazilian public spending established by the Federal Constitution. As highlighted by Santana et al. (2012), the Brazilian central government has obligations, guaranteed by the Constitution, that presents no possibility to be changed or reduced. Data from the National Treasury show that in 2016 these mandatory expenditures represent about 90% of the central government's primary expenditure, where the largest part relates to salaries. It demands the proposition of alternative policies other than reducing public spending. One alternative is to consider the public sector efficiency.

There are a plethora of empirical studies estimating tax compliance rates at the country level. A part of this literature considers a Value-Added tax - VAT compliance rate and/or VAT gaps. According to Sokolovska and Sokolovskyi (2015), one of the most important characteristics of this rate, hence the tax efficiency considered in this paper, is the estimation of the tax gap due to the tax non-compliance. Some of the works apply it in OECD countries (Agha and Houghton

(1996); OECD (2012)), others in terms of European Union countries (Nam et al. (2001); Christie and Holzner (2006); Barbone et al. (2013)) and also concerning countries worldwide (Keen (2013)).

There is no doubt that the ability to collect taxes is necessary to a country's capacity to finance its duties such as health and education, infrastructure, and other public goods and services. Additionally, issues concerning taxation and state-building have recently received attention in the literature. Braütigam et al. (2008) and Everest-Phillips (2009) emphasize the importance of political engagement and transparency as well as simple tax systems. According to Akitoby (2018), many countries might incur a sizable loss of revenue through ill-designed tax exemptions. However, regardless of the constraints countries might present, they can strengthen their potential to collect tax revenues by applying reforms, specifically in the tax systems.

Considering the basic needs a country is likely to present, Akitoby (2018) claims that the low level of tax collection might hinder economic development. Hence, it can also delay the recovery from the effects caused by extraordinary situations such as the Covid-19 pandemic. Moreover, results from Afonso et al. (2005), including three indicators to reflect the standard tasks of the government, which are allocation, distribution, and stabilization, suggest that there is a large potential for expenditure savings in many countries, in other words, gains of efficiency. Therefore, we may assume the feasibility of policies to improve public sector efficiency levels.

Additionally, assuming that the public consumption and public investment are associated with the provision of public goods and services for the households and public capital for the firms, Chatterjee and Ghosh (2011) claim that tax reforms performed by the government and imposing limits over the public spends might affect the level of wellbeing and efficiency of the economy. Therefore, simulating tax reductions could be appropriate in this approach.

High taxes negatively influence global tax competitiveness. In 2020, the Brazilian tax burden was around 31.64%[4]. According to Chen and Mintz (2015), Brazil presents a 31.7% of the marginal effective tax rate[5] on capital investment, which ranks in the 10th highest tax rate of a set composed by 90 countries in the year 2014. As a tax rate, it is considered that the higher the worse. Among 10 emerging countries within the economic group so-called G-20, the average of this tax rate is 23.5% and in OECD countries is 19.4%. The best-positioned country in Latin America is Chile with an 8.1% tax rate. This scenario in terms of high tax rates brings forth the need to discuss tax reductions and take their benefits. Notwithstanding, it would come along with an enhancement in the efficiency of taxation.

The topics concerning to taxation go beyond their own issues, they also influence the Global Competitiveness Index[6]. In 2014 Brazil was the 80th position in a list of 137 countries. Tax rates are at the top of the list of the most problematic factors for doing business in Brazil. Specifically, among the countries analyzed, the effect of taxation on incentives to work puts Brazil in the last position and the effect of taxation on incentives to invest makes it the second worst case.

The topics presented so far justify this paper. It applies a dynamic CGE model to evaluate possible gains in tax revenue, wellbeing, and other macroeconomics variables by simulating policies of improvements in efficiency in tax collection. The model is calibrated to represent the Brazilian economy. Additionally, extra simulation exercises are performed to propose a sustainable alternative to reduce tax rates, which compensates for the gains in revenue obtained with the efficiency improvements.

Aiming to avoid the reduction of the current level of tax revenue on which the functioning of the public sector depends, these alternative policies of recomposing tax revenues guarantee that the total tax revenue keeps at least the same level as observed before the implementation of the policy. It is emphasized that the simulated economic environment takes into account the Spending Cap Fiscal Regime as previously mentioned.

It is expected that this paper not only further our understanding but also contribute to the current public debate with important issues and findings concerning public sector efficiency in this specific form. Moreover, it might assist policymakers to design and/or evaluate appropriate public policies related to tax collection

Beyond this introduction, this paper contains five more sections. The following section describes the model and its components as well as specifies the variables and parameters. The third section describes the calibration process while specifying the data used for it. Simulation exercises are performed in the fourth section as well as reporting the findings. After that, some general comments and policy implications are presented and, finally, general remarks are drawn as a closure of it.

2. DYNAMIC COMPUTABLE GENERAL EQUILIBRIUM MODEL

This section describes the dynamic computable general equilibrium model based on a combination of models from Barro (1990) and Turnovsky (1996), as in Gomes et al. (2020), from which this paper also uses a similar notion for its variables and parameters. It regards a Neoclassical economic growth model featured by a closed economy. Based on Holland (2019), who states that the Brazilian case of the opening economy has not presented relevant changes over time, and also the fact this paper focuses on a specific issue related to the public sector, we emphasize that this characteristic brings no limitation to this analysis.

The contribution of this paper regarding the model for the aggregate economy is the insertion of efficiency parameters (ef_{tc}) in the tax collection equations. The main assumption behind it is that the government presents some level of inefficiency while performing tax collection activities.

2.1. Households

There are two types of households that use the services provided by the government not only through the availability of public infrastructure such as roads, airports, power, communications but also of public services such as public education and health as well as entertainment like parks and museums. The specification of the congestion in the public services is similar to the one found in Eicher and Turnovsky (2000) and Pintea and Turnovsky (2006). The main difference is that only one type is able to save and has access to the capital market. This type is named as the r households and the other as the p households.

It is emphasized that the services provided by the government directly increase the households' utility. However, some services are rivals and exclusive, then the congestion in consumption of public services is incorporated in this model similarly to Turnovsky (1996), for both types of households, as it follows.

$$cg_{p,t}^{S} = \frac{C_{g,t}}{N} \tag{1}$$

$$cg_{r,t}^{S} = \frac{C_{g,t}}{N} \tag{2}$$

$$N = N_p + N_r \tag{3}$$

where N represents the whole population, N_p is the number of households of the type p, and N_r is the number of the type r.

2.2. p Households

The group of households not able to save and/or to invest is called p households. It allocates its time in work ($h_{p,t}$) and the complement of it in leisure ($1 - h_{p,t}$), so that $h_{p,t} \in [0,1]$. It consumes from the private sector ($c_{p,t}$) and from the public sector ($cg_{p,t}^{S}$), where part of the public services is subject to congestion in its use. Therefore, given an intertemporal discount factor, $\beta \in (0,1)$, the households have preferences about the flows of private consumption and leisure as the utility function specifies below.

$$U_p(c_{p,t}, h_{p,t}, cg_{p,t}^S) = \sum_{t=0}^{\infty} \beta^t (1+n)^t \{\ln(c_{p,t} + \mu\, cg_{p,t}^S) + \psi_p \ln(1-h_{p,t})\}, \mu \geq 0 \quad (4)$$

where μ represents how much this type of individual values public services compared to private consumption, n is the population growth rate, ψ_p shows how they value leisure, and $h_{p,t}$ represents the average worked hours. It is supposed that consumption and labor are taxed based on the respective rates $\tau_{c,p}$ and $\tau_{h,p}$. Therefore, the budget constraint of the p households is given by:

$$(1+\tau_{c,p})c_{p,t} = (1-\tau_{h,p})\xi_p w_t h_{p,t} + tr_{p,t} \quad (5)$$

where ξ_p is the labor productivity, w_t is the average gross salary, it means, before taxes, and $tr_{p,t}$ represents the transfers from the government to this type of household.

2.3. r Households

The rest of the households in this economy are compiled into another group, called r households, which are able to save and invest. Like the previous group, they allocate their time to work and leisure and also consume goods and services from both the private and the public sectors. The r households' utility is, therefore, given as follows.

$$U_r(c_{r,t}, h_{r,t}, cg_{r,t}^S) = \sum_{t=0}^{\infty} \beta^t (1+n)^t \{\ln(c_{r,t} + \mu\, cg_{r,t}^S) + \psi_r \ln(1-h_{r,t})\}, \mu \geq 0 \quad (6)$$

Here, the characteristics of the preferences about the leisure and the average worked hours, the productivity, and the transfers from the government are specific and represented respectively as ψ_r, $h_{r,t}$, ξ_r, and $tr_{r,t}$. Besides, differently from the p households, they are endowed with a stock of capital (k_t) and government bonds (b_t), which give them the returns of $r_t k_t$ and $\rho_t b_t$. It is supposed that all of the sources of income, as well as the consumption, are taxed based on the taxes $\tau_{c,r}$, $\tau_{h,r}$, τ_k, and τ_b.

This representative r household starts with a stock of capital, k_0, and decides how much to increase it through investments. Every period of time, this capital depreciates at a constant rate of δ, with $0 < \delta < 1$. Once there are n households of this type, the composition of their investments makes the capital grows at a rate of $(1+n)$. Therefore, this physical capital evolves as follows:

$$(1+n)k_{t+1} = (1-\delta)k_t + i_t \quad (7)$$

The budget constraint is applied every period limiting the spends in consumption ($c_{r,t}$), investment (i_t), and accumulation of government bonds ($b_{t+1} - b_t$), as described below:

$$\begin{aligned}(1+\tau_{c,r})c_{r,t} + i_t + \big((1+n)b_{t+1} - b_t\big) \\ = (1-\tau_{h,r})\xi_r w_t h_{r,t} + (1-\tau_k) r_t k_t + (1-\tau_b)\rho_t b_t + tr_{r,t}\end{aligned} \quad (8)$$

Finally, since the households are supposed to maximize their utility every period of time, satisfying their respective budget constraints. Thus, the problem of the p household is to maximize (4) subject to (5) while the r household maximizes (6) subject to (8). Both types must take into account the congestions present in equations (1) and (2).

2.4. Firms

The representative firm yields a final good through a Cobb-Douglas function based on Eicher and Turnovsky (2000). So, to produce Y_t, it uses private capital (K_t), labor (H_t), and stock of public capital ($K_{g,t}^S$). Similar to Uzawa (1961), it is assumed that the production function shows productivity growth allowing the economy to grow in *per capita* terms in the long term. The technological progress (A_t) increases the labor and grows at a rate $(1+g)$. Thus, the production function is:

$$Y_t = A K_t^{\sigma_K} (A_t H_t)^{1-\sigma_K} \big(K_{g,t}^S\big)^{\gamma} \quad (9)$$

where $K_{g,t}^{S} = \frac{K_{g,t}}{K_t}$.

It is assumed that the firm maximizes profit (Π_t) in a way that on the equilibrium the gross return of capital is equal to r_t, and the wages before taxes are w_t. Therefore, for each period t, the firm's problem of maximizing is:

$$\max_{K_t, H_t} \Pi_t = \left\{ A K_t^{\sigma_K} (A_t H_t)^{1-\sigma_K} \left(K_{g,t}^{S}\right)^{\gamma} - w_t H_t - r_t K_t \right\} \tag{10}$$

2.5. Government

The tax revenue (T_t) is basically composed by the taxes over the consumption $\tau_{c,p} C_{p,t}$ and $\tau_{c,r} C_{r,t}$, the income from labor, $\tau_{h,p} w_{p,t} H_{p,t}$ and $\tau_{h,r} w_{r,t} H_{r,t}$, the return from the capital, which covers both direct and indirect taxes, $\tau_k r_t K_t$, and the return of the public bonds, $\tau_b \rho_t B_t$. Besides, the government can also raise funds by issuing new government bonds. Into this process, there are efficiency parameters (ef_{tc}) associated with all the tax bases, except for the one that is levied on the returns of government bonds. It is due to the fact the government exerts direct control over it. Thus, the government's budget constraint, as well as the equation that determines tax collection, are represented by the following equations, respectively.

$$T_t + (B_{t+1} - B_t) = C_{g,t} + I_{g,t} + TR_{p,t} + TR_{r,t} + \rho_t B_t \tag{11}$$

$$\begin{aligned} T_t = {} & \tau_{c,p}\, ef_{tc}\, C_{p,t} + \tau_{c,r}\, ef_{tc}\, C_{r,t} + \tau_{h,p}\, ef_{tc}\, \xi_p w_{p,t} H_{p,t} + \tau_{h,r}\, ef_{tc}\, \xi_q w_{r,t} H_{r,t} \\ & + \tau_k\, ef_{tc}\, r_t K_t + \tau_b \rho_t B_t \end{aligned} \tag{12}$$

where $B_t = N_{r,t} b_t$ is the stock of aggregate public bonds.

Additionally, the public capital evolves over time as represented below. Where δ_g represents the depreciation rate of public capital and I_g is the public investments.

$$K_{g,t+1} = (1 - \delta_g) K_{g,t} + I_{g,t} \tag{13}$$

Every period t, the government allocates a share of the GDP to finance public services, public investment, and transfers to the households. Thus, the fiscal policies are specified as $C_{g,t} = \alpha_g Y_t$, $I_{g,t} = \alpha_I Y_t$, $TR_{p,t} = \alpha_p Y_t$ e $TR_{r,t} = \alpha_r Y_t$, where the $\alpha_g, \alpha_I, \alpha_p$, and α_r are the policy parameters.

2.6. Equilibrium in the aggregate economy

Given sequences of fiscal policies $\{\tau_{c,p};\ \tau_{c,r};\ \tau_{h,p};\ \tau_{h,r};\ \tau_k; \tau_b;\ \alpha_g;\ \alpha_I;\ \alpha_p\}_{t=0}^{\infty}$ and efficiency levels $\{ef_{tc}\}_{t=0}^{\infty}$, the equilibrium is set by a sequence of households' decisions, $\{c_{p,t}; c_{r,t};\ i_t; h_{p,t}; h_{r,t}; b_{t+1}\}_{t=0}^{\infty}$, by an optimal sequence of stocks of private and public capital $\{K_t; K_{g,t}\}_{t=0}^{\infty}$, by a sequence of prices of factors $\{w_{p,t}; w_{r,t}; r_t\}_{t=0}^{\infty}$, and the interest rate of the public debt, $\{\rho_t\}_{t=0}^{\infty}$. It is compatible with the optimization problems of both types of households and the firm, the conditions for aggregating individual decisions, which are represented as ($C_{p,t} = N_p c_{p,t}$; $C_{r,t} = N_r c_{r,t}$; $C_t = C_{p,t} + C_{r,t}$; $K_t = N_r k_t$; $TR_{p,t} = N_p tr_{p,t}$; $TR_{r,t} = N_r tr_{r,t}$; $I_t = N_r i_t$; $B_t = N_r b_t$; $H_{p,t} = N_p h_{p,t}$; $H_{r,t} = N_r h_{r,t}$), the government budget constraint, and finally, the constraint of the total resources in the economy: $C_t + C_{g,t} + I_t + I_{g,t} = A K_t^{\sigma_K} (A_t H_t)^{1-\sigma_K} \left(K_{g,t}^{S}\right)^{\gamma}$.

2.7. Wellbeing analysis

Given the basic fiscal policies in steady-state as show in the previous section, to calculate the variation of the wellbeing of the households from a change in the fiscal policy it uses a traditional method widely applied in the literature such as Chari et al. (1994, 1995), Pereira and Ferreira (2008, 2011), Bezerra et al. (2014), Gomes et al. (2019; 2020).

The measurement of wellbeing corresponds to the percentage change in consumption,

x, related to the steady-state, keeping constant the hours worked and the consumption of public services in the levels also observed in the steady-state, required to equalize the level of utility to the one observed if the policy has been in fact applied. Thus, it must satisfy the following equation.

$$\sum_{t=0}^{\infty} \beta^t (1+n)^t \{\ln(c_{i,t}^{BP}(1+x) + \mu_i\,(cg_{i,t}^{S})^{BP}) + \psi_i \ln(1-h_{i,t}^{BP})\} = \sum_{t=0}^{\infty} \beta^t (1+n)^t \{\ln(c_{i,t}^{AP} + \mu_i\,(cg_{i,t}^{S})^{AP}) + \psi_i \ln(1-h_{i,t}^{AP})\} \quad (14)$$

In order to avoid replicating a similar equation, consider a general term i to represent the Households r and p. Additionally, consider BP meaning before the policy, and AP meaning after the policy.

3. CALIBRATION

The calibration process for the parameters uses information from official data provided mainly through government agencies and departments, namely that, Brazilian Institute of Geography and Statistics (IBGE), National Household Sampling Survey (PNAD, 2014), Federal Government Transparency Portal, and Management Reports from the Federal Revenue Service (SRF). It closely follows Gomes et al. (2019) and Gomes et al. (2020).

Assuming that the Brazilian economy was on a stationary path in 2014, the calibration process is carried out so that there is a correspondence between the stationary solution of the model and the observed data of the Brazilian economy in this particular year. Thus, since efficiency is the main topic, the efficiency parameters are specified first in this section. Then, the division of the households is specified and the model parameters are divided and presented in i) technology parameters ($\sigma_K, \delta, \delta_g, \gamma, A, n, g, \xi_p, \xi_r$); ii) fiscal parameters ($\tau_{c,p}, \tau_{c,r}, \tau_{h,p}, \tau_{h,r}, \tau_k, \tau_b, \alpha_g, \alpha_I, \alpha_p, \alpha_b$); and iii) preference parameters ($\beta, \mu, \psi_p, \psi_r$).

Firstly, concerning the parameters of efficiency, which are associated with collecting taxes, for simplicity, it is assumed that the efficiency of of tax collection is equal for all the tax bases (ef_{tc}). This paper uses the estimation for the Brazilian case in 2012 from Sokolovska and Sokolovskyi (2015), which is 75%. Once the calibration process considers the base year of 2014, it assumes that this two-year lag is insignificant since efficiency will likely remain constant over time in a context with no intervention. Therefore, $ef_{tc} = 0.75$. The VAT efficiency ratio estimation follows the equation:

$$Ef_{vat} = \frac{REV_{VAT\_act}}{REV_{VAT\_est}} * \frac{Base_{VAT}}{Cons} \quad (15)$$

where REV_{VAT_act} and REV_{VAT_est} are respectively the actual and estimated VAT revenue, $Cons$ represents the final consumption of the households as a share of the GDP, and $Base_{VAT}$ represents the VAT tax base. Sokolovska and Sokolovskyi (2015) emphasize that this equation already considers the presence of factors that negatively affect the VAT efficiencies, such as tax evasion and underpayment of taxes.

3.1. Households' classification

The classification of households considers both household income *per capita* and the access, or not, to financial assets, such as savings, dividends, and rents, as well as the possession of movable and/or immovable properties. Firstly, it uses the criterion of a quarter (1/4) of a minimum wage, below or equal this value it belongs to the p households, and above it is qualified to be into the r group of households. Although controversial, poverty thresholds measures based on a salary share are widely applied into the literature and so are used by the governments to determine social assistance programs, as indicated in Loureiro et al. (2010).

The division is based on Gomes et al. (2020), which identifies households with interest and dividend income. It uses microdata available on the Transparency Website on payments made to households during 2014 related to social security programs as well as assistance programs to reduce the identification bias.

Based on the classification and in the number of households in Brazil, which in 2014 was about 67.2 million, it is identified that 16.73% belongs to the p households, so that N_p= 11,236,463. On the other hand, 83.27% belongs to r households, so that N_r = 55,937,699. Therefore, $L_p = 0.1673$ and $L_r = 0.8327$.

Once the classification of the households is done, it was identified that the average monthly income *per capita* of all the p households is approximately R$ 552.78, whereas for the r group was around R$ 1,156.71. Regarding the income of all sources, the households of the types p and r get, respectively, R$ 852.37 and R$ 2,064.22.

It considers the average annual total hours worked per Brazilian worker obtained from the Penn World Table (PWT), referring to the period from 2006 to 2014. Therefore, $H = 0.2930$. Data from PNAD (2014) indicates that the total amount of worked hours on average the households p and r spend working are 22.24 and 24.69, respectively. Assuming that the relationship between the weekly working hours of types p and r follows the relationship between the hours of PNAD, then, given L_p, L_r, H and the relationship between the average wages of each type in PNAD, is determined as $h_p = 0.338$ and $h_q = 0.321$. It is similar to the value estimated for Cooley and Prescott (1995) for the American economy, which shows that American workers spend about one-third of their daily hours working.

3.2. Technology parameters

The depreciation rate of public and private capital comes from their main equation in steady-state. Therefore, solving $(1+n)(1+g)K_{t+1} = (1-\delta)K_t + I_t$ for the depreciation rate, it generates $\delta = I_t/K_t - g - n - g*n$. Similarly, solving $(1+n)(1+g)K_{g,t+1} = (1-\delta_g)K_{g,t} + I_{g,t}$, it generates $\delta_g = I_g/K_g - g - n - g*n$. The calibration of these parameters uses the average of data from 1998 to 2008. The average ratios of ($I_{g,t}$ /$K_{g,t}$) and (I_t/K_t) are, 0.0509 and 0.0786, respectively. The population growth rate for this period, in turn, is about 1.97%, which makes $n = 0.0147$. Finally, for the growth rate of the labor productivity, it uses the average rate of the ratio of real GDP over the economically active population (PEA), which gives $g = 0.0055$. Thus, the calibration returns $\delta_g = 0.0305$ and $\delta = 0.0581$.

It is emphasized that the values for g and n showed in the previous paragraph are calibrated specifically for the depreciation parameters, it means the calibration itself takes into account other values for these parameters. Therefore, taking the same formula but the period from 1993 to 2013, which is larger than the previous one, so it is considered more accurate for the calibration as a whole. Thus, $g = 0.0111$. The population growth rate in 2014 was around 0.86%, hence $n = 0.0086$. The total productivity of the factors (A) is calibrated so that the stationary product in efficiency units is equal to the unity. Therefore, $A = 1.5044$.

The parameter γ expresses the value of the public capital of infrastructure on the economy's outcome. It comes from Ferreira (1993) and Ferreira e Nascimento (2006), which estimated the value of $\gamma = 0.09$. This value has been applied widely in the literature in Brazil (Bezerra et al. (2014), Gomes et al. (2019), Gomes et al. (2020)).

The returns of capital as a share of the GDP is measured as the sum of gross operating surplus with one-third of gross mixed-income as a share of GDP at cost of factors, which is obtained by subtracting taxes and subsidies on production and imports from GDP. From official data, the value of $\sigma_K = 0.4221$ is calibrated. As a result, the share of the returns of the labor must be the complementary part of it $(1-\sigma_K) = 0.5779$. Indeed, these values are close to those found in the literature such as Pereira and Ferreira (2010), Santana et al. (2012), Bezerra et al. (2014),

and Campos and Pereira (2016). Table 1 summarizes the values of these parameters.

Considering that both types of households have the same preferences over the leisure time and that the r household is the most similar to represent the average individual in the economy, $\xi_r = 1$, plus the average worked hours from PNAD, it implies that the preferences of leisure are compatible to the value of $\psi_p = \psi_r = 1.2848$. Based on that, the productivity of the p household is $\xi_p = 0.4540$.

Table 1 - Technology parameters.

σ_K	n	g	δ_g	δ	γ	A	ξ_p	ξ_r
.4221	.0086	.0111	.0305	.0581	.09	1.5044	.4540	1

Source: Authors' elaboration.

3.3. Fiscal Parameters

The tax rate over the consumption is calculated from a share of the tax revenue over the final consumption. In 2014 the tax revenue over the consumption was 9.13% of GDP as the final consumption was 62.95% of the GDP, implying in $\tau_c = 0.1451$. Considering the tax revenue over the labor, which was 8.98% of the GDP, and the income of the labor as a share of the GDP, as in $w_t H_t / Y_t = (1 - \sigma_K) = 0.5779$, there is $\tau_h = 0.1555$. Therefore, assuming that the p households pay only the minimum tax rate of the social security system (INSS), which is equivalent to 8% ($\tau_{h,p} = 0.08$) and that the total revenue from labor as a GDP share is expressed as $\tau_{h,p}\xi_p w h_p L_p + \tau_{h,r}\xi_r w h_r L_r = (Tax\ Rev.Labor/Y_t)$, it yields the value of $\tau_{h,r} = 0.1628$.

Based on reports of the public debts, from the National Treasury Secretariat (STN) and Law number 11.033 (Dec. 21, 2004), the average of tax rates over the public bonds returns weighted by different shares of maturity is about 16.97%. Then, it determines $\tau_b = 0.1697$.

The tax revenue over the returns of capital and bonds as a share of the GDP is about 13.78% and it can be represented as $(\tau_k r_t K_t + \tau_b \rho_t B_t)/Y_t$. It firstly requires the stock of public debt (B) and its real interest rate (ρ_t). Data from the Central bank shows that in December of 2014, the net public debt was around 32.58% of the GDP, which is represented as $\alpha_b = 0.3258$. The series of the real interest rate of the public debt is defined from the expression $\rho_t = (\rho_t^n - \pi_t)/(1 + \pi_t)$, where ρ_t^n is the nominal interest rate and π_t is the inflation rate set by the Wide Consumer Price Index (IPCA). The average real interest rate on public debt between January 2008 and December 2011 is $\rho = 7.57\%$. Finally, using the elasticity of the outcome related to the capital (σ_k) already calibrated before, the calibration of this parameter is obtained as $\tau_k = 31.65\%$.

The shares of the government's consumption and investment are represented, respectively, for α_g and α_I. Based on the sum of the macroeconomic aggregate collected in the National account system, the final consumption of the public administration was 19.15% of the GDP and the gross fixed capital formation of the government, which is a widely accepted proxy for the government investment, was 2.96% of the GDP. Then, it generates, respectively, $\alpha_g = 0.1915$ and $\alpha_I = 0.0296$.

Finally, the average transfers from the government to the households represent the ratio of $tr_{p,t}/tr_{r,t} = 0.0869$. Once the total amount transferred is composed by the sum of the individual transfers, including it into the government budget constraint plus being aware that in steady-state the outcome of this economy is calibrated to the unity, the transfers to the p households as a share of the GDP are set as $\alpha_p = 0.0061$.

Table 2 - Fiscal parameters.

τ_c	$\tau_{h,p}$	$\tau_{h,r}$	τ_b	τ_k	α_g	α_I	α_b	α_p
.1451	.08	.1628	.1697	.3165	.1915	.0296	.3258	.0061

Source: Authors' elaboration.

3.4. Preference parameters

For the parameter μ, it is considered the value of 0.5, which is a value widely used in the literature (Ferreira and Nascimento (2006); Santana, Cavalcanti, and Paes (2012); Bezerra et al. (2014); Gomes, Pereira, and Bezerra (2019); Gomes et al. (2020)). Most of these authors are based on Bailey (1971) and Barro (1981), which in turn state that individuals interpret public spending as a substitute for private consumption.

The intertemporal discount factor (β) is calibrated from the household's first order condition in steady-state. As it is a behavioral parameter, it considers the parameters already calibrated above. Thus, it takes into account the formula $\beta = \frac{1+g}{1+\rho(1-\tau_b)}$ and the values of $g = 0.0111$, $\rho = 0.0757$, and $\tau_b = 0.1697$, that generates $\beta = 0.9513$.

The preferences for leisure were already introduced combined with the parameters of productivity in the section of the technology parameters. They are compatible to the value of $\psi_p = \psi_r = 1.2848$.

Table 3 - Preference parameters.

μ	β	ψ_p	ψ_r
.5	.9513	1.2848	1.2848

Source: Authors' elaboration.

4. SIMULATION EXERCISES AND RESULTS

Aiming to provide a clear explanation of the results, this section is divided into two parts. It firstly analyzes a policy of a 10% improvement in tax collection efficiency. Then, it simulates different policies of tax reductions on the country level combined with this 10% improvement in tax collection efficiency.

4.1. Increasing efficiency in tax collection in Brazil

According to Arbel et al. (2019), statistical test outcomes support Laffer's controversial claim that for the few upper-bracket taxpayers, an efficient collection is associated with tax reduction rather than tax increase. Similarly, Romer and Romer (2010) show that tax increases are highly contractionary. Therefore, even though increasing tax rates seems to be the easiest way to improve tax revenues, required due to the current fiscal imbalance in the Brazilian central government, it would likely yield opposite outcomes, making the Fiscal deficit currently observed even worse. Thus, this work proposes increasing efficiency as an alternative to increase tax revenues, hence a potential way to overcome the current fiscal situation.

Based on the main topic developed in this paper, it simulates a policy of an increase in efficiency in tax collection. The magnitude of the change is arbitrarily chosen. Thus, the policy consists of an increase of 10% in the efficiency in tax collection, which goes from the assumed initial value of 0.75 to 0.825. The assumption behind this choice is that there is one part of the total inefficiency level that can be improved without changing the perception or willingness of the taxpayers. For simplicity, this improvement is assumed to be similar in all sources of tax collection. Increases in efficiency like this could be obtained by performing improvements in technology

systems and changes in specific laws making the process easier.

The improvement in efficiency in tax collection would return an increase in tax revenue. Since the shock is implemented once for all, this increase in tax revenue is around 9.85% immediately in the first period after the implementation. It is a little shorter than the 10% shock due to the incidence of efficiency, which excludes the income coming from the public debt as assumed in the model description.

Therefore, given the current scenario described regarding the public finances, these possible extra revenues might be used firstly to mitigate the pandemic effects on public finances and then for other purposes such as reducing the public debt. This first simulation is used in the following section as the start point to base compensations of tax rate reductions.

4.2. Compensation in the tax revenue components

As already mentioned in the introduction, the tax burden in Brazil is high simultaneously with a fiscal imbalance in the Brazilian central government due to deficits in the past few years and the post-pandemic current scenario. However, there still might be some margin to apply tax rate reductions, highly unlikely in an isolated form but instead by implementing some compensation.

One way this compensation can generate is by adapting the double dividend hypothesis and using the recycling revenue issues. Fullerton and Metcalf (1997), through the double-dividend hypothesis, state that creating or raising taxes on polluting activities might be able to provide two types of benefits. The first one regards improving the environment by reducing pollution, and the second concerns the economy's efficiency by using the tax revenues collected by the new or higher taxes to reduce other taxes, also known as recycling revenues. However, it emphasizes that the validity of this hypothesis must not be considered applicable in a general matter. Following this specific issue, after performing simulations, Freire-Gonzalez (2018) claims that even though the environmental benefits are accomplished generally due to the fact the changes in taxes also change the behavior of the economic agents, there is no consensus in the literature, suggesting that it still needs further research.

In this literature, Goulder and Hafstead (2013) and Beck et al. (2015) apply general equilibrium models, the former for the United States and the latter for Canada. Goulder and Hafstead (2013) evaluate the alternatives of tax reductions to be financed by the revenues from an environmental tax. They found that this specific tax promotes a substantial net revenue and that the impacts on GDP and wellbeing depend strongly on how this revenue is recycled to benefit the productive sectors.

Once this paper proposes an alternative to overcome the unbalanced public finances in Brazil, it simulates policies of compensation focusing on the tax revenue. It is due to the current scenario of the public finances in Brazil that combines consecutive fiscal deficits with the effects of the Covid-19 pandemic, which required an increase in spending on health and transfers to subnational units, as well as cash transfers to aid poor households at the same time the economic activity restrictions reduced tax revenue. Therefore, it is questionable whether Congress would approve some tax policies reducing the tax revenue in the short run. Thus, the compositions of tax revenue drivers must be such that it results in at least the same amount of revenue collected before the implementation.

Roughly speaking, assuming that creating or increasing some tax generates higher tax collection allowing the reduction of some others, this process can be seen as a composition of revenues. Therefore, it might be feasible to compensate the components of the tax collection considering the efficiency of collecting. In this regard, consider the following construction that formalizes this idea.

Let the equation for Tax Collection be represented by the equation 12, previously shown. Rewriting it and putting the efficiency in evidence, it can be expressed as follows: $T_t = ef_{tc} * (\tau_{c,p} C_{p,t} + \tau_{c,r} C_{r,t} + \tau_{h,p} \xi_p w_{p,t} H_{p,t} + \tau_{h,r} \xi_q w_{r,t} H_{r,t} + \tau_k r_t K_t) + \tau_b \rho_t B_t$. At time t, the

efficiency covers the incidence bases of consumption, work, and capital, with the respective tax rates $\tau_{c,p}$, $\tau_{c,r}$, $\tau_{h,p}$, $\tau_{h,r}$, and τ_k. Therefore, the efficiency, the tax rates, and the incidence bases are the components of the tax revenue. Thus, mathematically, for a given level of efficiency, higher than the current value, there is at least one value for each tax rate, considering them individually or in aggregate, lower than the current value, able to yield either the same level or a higher level of Tax revenue, *ceteris paribus*.

Keeping the modest change of a 10% reduction in the efficiency level, as performed above, and applying the compensation of the tax revenue components to keep the total tax revenues unchanged at least in the oncoming years, which are harder to adapt the budget given the problems discussed, this work simulates policies consisting in reductions of the tax rates both individually and combined. The following table brings a short description of the policies proposed, contributing to ease the understanding of them.

Table 4 - Description of the policy simulations applying the compensation of the tax revenue components considering a generalized 10% increase in efficiency in tax collection.

Policies	Description
Policy 1	Reduction of 40.3% on tax rates over consumption, $\tau_{c,p}$ and $\tau_{c,r}$.
Policy 2	Reduction of 41.3% on tax rates over work, $\tau_{h,p}$ and $\tau_{h,r}$.
Policy 3	Reduction of 23.9% on tax rates over capital, τ_k.
Policy 4	Reduction of 20.5% on tax rates over consumption and work, $\tau_{c,p}$,$\tau_{c,r}$,$\tau_{h,p}$, and $\tau_{h,r}$.
Policy 5	Reduction of 11.2% on tax rates over consumption, work, and capital, $\tau_{c,p}$, $\tau_{c,r}$, $\tau_{h,p}$, $\tau_{h,r}$, and τ_k.

Source: Authors' elaboration.

Given the policies properly presented, we address them just by their codes. Remember that all policies consider a 10% increase in tax collection efficiency. The following table reports the steady-state results, in percentage variation, for some of the macroeconomic variables considered in the model and for all policies proposed. It should be emphasized that the variables, as well as the wellbeing gains, are determined by the *per capita* variables and take into account the increases in the population growth rate and productivity together, $(1+n)(1+g)$, being transformed therefore in efficiency units. Besides, it is worth mentioning that these same factors cause a drop in the variables in efficiency units.

Table 5 - Steady-state results for selected macroeconomic variables for all policies.

Variable	Policy 1	Policy 2	Policy 3	Policy 4	Policy 5
GDP (Y)	3.59	5.06	8.30	4.36	6.34
Consumption p HH* (Cp)	5.92	3.38	5.92	4.66	5.40
Consumption r HH (Cr)	3.40	5.20	4.65	4.33	4.65
Consumption of Gov.** (Cg)	3.59	5.06	8.30	4.36	6.34
Investment of Gov. (Ig)	3.59	5.06	8.30	4.36	6.34
Private Investment (I)	3.59	5.06	20.29	4.36	11.86
Transfers p HH (TRp)	3.59	5.06	8.30	4.36	6.34
Worked Hours p HH(hp)	.11	-.004	-.005	-.002	-.003
Worked Hours r HH (hr)	3.93	5.58	2.21	4.79	3.65
Wage (w)	.00	.00	6.22	0.00	2.95
Interest rate (r)	.00	.00	-.10	.00	-.05
Private Capital (K)	3.59	5.06	20.29	4.36	11.86

Capital of Government (Kg)	3.59	5.06	8.30	4.35	6.34
Tax Revenue (T)	1.15	1.85	5.87	1.48	3.52
Wellbeing (Δ%) p Household	6.29	4.44	6.32	5.38	5.97
Wellbeing (Δ %) r Household	.18	.56	.03	.38	.30

Source: Authors' elaboration. Note: *HH = Households. **Gov.=Government.

Firstly, since the results are presented as percentage variations, similarities among them stand out. More specifically, concerning GDP and some variables driven by the government, such as the public consumption, transfers to the p households, and public investment that makes the public capital grow at the same rate. It is due to the fact these variables are shares of the GDP.

Considering only the steady states, in other words, disregarding the transition from the initial period to the new equilibrium the economy achieves after policies, all policies return positive changes for the main variables considered, such as GDP, private consumption for both households, and tax revenue.

Policy 3, which reduces the tax rate over the capital, yields the highest effect on GDP and the well-being of poor households. This effect on GDP follows the impact this policy plays on private investment. This kind of policy exerts good incentives on the productive sector. Therefore, it is an expected result. Besides, this impact on GDP also raises the tax revenue, resulting in the highest variation of the policies.

Policy 1 yields the second-highest wellbeing variation for p households. Although it presents the smallest impact on GDP of all simulations, a 3.59% increase in GDP is considered a good outcome, it represents a growth rate higher than those observed recently. This policy incentivizes consumption the most, and poor people tend to absorb these incentives promptly, assuming their basic needs were not being completely covered before the implementation.

The bolder policy, Policy 5, which applies a reduction in all tax rates the government is supposed to exert some efficiency collecting, reaches the second highest result for GDP, about a 6.34% increase in the long term. As previously discussed the Policy 3, this policy incentivizes investments, which in turn enlarges the potential of the GDP. The results show that policies that reduce tax rates over the capital, either purely or combined, yield the most significant changes in GDP.

Although negative variations are observed in the working hours of the poor households for all policies, except for Policy 1, it emphasizes that these variations are minor. Nevertheless, these changes increase leisure time, a positive factor in the utility function. On the other hand, it might reduce the returns from work and, as a result, reduce consumption, which is another positive factor of the utility function. A matter of fact is that the net effect observed by the positive well-being variation is positive.

Regarding the steady-state analysis, it highlights only the outstanding results. From now on, the exploration lies in the dynamics provided by the model. This analysis is more thorough since it is possible to look at the behavior of the variables right after the policies were started and through the years. Table 6 compiles the results for all Policies for selected variables.

Table 6 - Dynamic results (% changes) for selected macroeconomic variables of all policies.

Policy/Variables*	Time period after implementation (years)					
Policy 1	1	2	4	8	16	50
GDP	2.42	2.51	2.68	2.91	3.16	3.48
Tax Revenue	.00	.17	.32	.52	.75	1.04
Consumption p HH	4.01	4.20	4.51	4.95	5.38	5.80
Consumption r HH	1.13	1.37	1.76	2.29	2.82	3.27
Private Investment	6.01	5.65	5.06	4.31	3.68	3.52

Households' Wellbeing	p type		6.29	r type		.18
Policy 2	1	2	4	8	16	50
GDP	3.39	3.52	3.76	4.09	4.45	4.89
Tax Revenue	.00	.30	.54	.88	1.25	1.69
Consumption p HH	.77	1.03	1.46	2.05	2.64	3.20
Consumption r HH	1.99	2.32	2.87	3.62	4.37	5.01
Private Investment	8.42	7.92	7.11	6.05	5.17	4.95
Households' Wellbeing	p type		4.44	r type		.56
Policy 3	1	2	4	8	16	50
GDP	3.35	3.88	5.88	5.88	6.99	8.01
Tax Revenue	.00	1.08	3.26	3.26	4.50	5.57
Consumption p HH	-3.21	-2.15	1.87	1.87	4.05	5.60
Consumption r HH	-6.68	-5.35	-.25	-.25	2.49	4.33
Private Investment	36.29	34.18	25.98	25.98	21.76	20.09
Households' Wellbeing	p type		6.32	r type		.03
Policy 4	1	2	4	8	16	50
GDP	2.93	3.04	3.24	3.40	3.84	4.22
Tax Revenue	.00	.22	.41	.56	.98	1.34
Consumption p HH	2.37	2.60	2.97	3.26	4.01	4.51
Consumption r HH	1.58	1.86	2.34	2.70	3.62	4.18
Private Investment	7.27	6.84	6.13	5.61	4.46	4.27
Households' Wellbeing	p type		5.38	r type		.38
Policy 5	1	2	4	8	16	50
GDP	3.16	3.48	4.00	4.71	5.43	6.12
Tax Revenue	.00	.64	1.16	1.88	2.61	3.31
Consumption p HH	-.24	.39	1.43	2.82	4.15	5.16
Consumption r HH	-.023	-.015	.002	1.56	3.23	4.41
Private Investment	21.13	19.86	17.78	15.01	12.59	11.71
Households' Wellbeing	p type		5.97	r type		.30

Source: Authors' elaboration. Note: *All results are displayed in percentage variations.

As long as consumption demands a significant share of the resources of poor people, being aware that sometimes it is not even enough for their basic needs, Policy 1 reaches the highest impact on consumption of these households. It would increase their consumption by about 4% in the first year after the implementation, reaching 4.5% within four years and reaching an almost 5% increase in 8 years. Besides, since consumption is a significant share of GDP, this policy would generate a 2.4% increase in GDP in the first year, achieving more than 3% after 16 years. A considerable positive result, although the lower of all policies.

This policy would be responsible for the second-highest well-being gains for poor households of all Policies. Once the composition of the utility also considers the consumption of public goods, which grows accordingly to the growth rate of the GDP, it compensates for the raising of private consumption into the composition of utility, softening it.

Policy 2, which focuses on reducing tax rates over the labor force, also reaches considerable positive effects in all the variables displayed in the table. The positive variation on GDP is the highest in the first year after the implementation, slightly higher than it would observe

in Policy 3, which, by the way, would proportionate the highest long-run variation on GDP. Nevertheless, Policies 3 and 5 overcome this variation over the years.

Policy 3 would proportionate the highest variation of investment, over 36% in the first period, and then diminish, ending with a still high variation of 20%. Before questioning these magnitudes, one might first remember that this policy applies a 23.9% drop in tax rates over the capital. This policy has the best incentives for investments. The effect is reflected positively in both fiscal and macroeconomic aspects. In terms of macroeconomics, it helps to bypass the economy's bottlenecks, specifically on the supply side. This booster effect, in turn, promotes an augmented tax revenue, hence facilitating balanced fiscal management and getting extra resources for reducing public debt.

Despite the positive effects on GDP, the negative impact on private consumption over the first periods for both households stands out. The p households achieve a positive variation in the fourth year after implementation. On the other hand, the r households last over ten years to achieve the same. In this case, since the r households are also investors, their incentives to allocate their incomes change when the tax rate drops. Hence, they might be reallocating their income from consumption to investments in the first period. Regarding the p households, these rearrangements of investments are causing a reduction in working hours by around 1.5%, while the first years converge to the initial value in the long run. It would explain the decrease in consumption right after the implementation.

Once again, Policy 4 would result in positive effects for all variables discussed. As a combination of policies 1 and 2, it also compiles features from them, such as a high incentive for consumption, which turns out to be the second-highest among the policies. In terms of tax revenue, it would increase over a half percent in 8 years and around 1% in 16 years, which overcomes the level of variation performed by Policy 1.

Finally, the bolder policy simulated in this paper applies reductions in all tax rates the government may express inefficiency, Policy 5 would require a significant political effort to implement. We highlight it is still considered feasible and could be implemented by a reform in the tax system, which is already being discussed in the Congress. Once it evolves a variety of tax rates, the percentage of reduction is smaller than those required for the other policies. It seems to be a positive factor to legitimate its feasibility in a possible reform.

A noteworthy result is that Policy 5 would achieve the highest increase of tax revenue variation among the policies simulated. More specifically, it would be over 0.6% in the second year and almost 2% in 8 years. Remember that this generalized effort requires a drop around 11.2%, which is considerably lower than other reductions that have been simulated so far concerning specific tax rates, namely that, Policies 1, 2, and 3. This percentage of reduction combined with the gains reported also helps to justify some efforts to implement these policies.

Given its generalized tax reduction, it compiles the incentives from the specific policies highlighting some features. This is the case of the negative variation of the consumption, similar to those observed in policy 3. However, in this case, it is lower due to the lower reduction of the tax rates. Besides, it turns to a positive variation faster for both types of households.

As shown, all of these simulated policies yield positive gains in GDP, well-being for both types of households, and a sustainable way to increase tax revenue over the years, providing an alternative to solve or at least mitigate the problems in public finances in Brazil. Therefore, the results described throughout this section demonstrate the need to consider public policies of efficiency improvements as well as tax reductions.

5. DISCUSSION AND POLICY IMPLICATIONS

Brazil has shown an expressive increase in the Gross Debt of the Central Government since 2001. According to Souza Junior and Santos (2017), a factor contributing to this is the continuity of tax exemptions. Therefore, increasing efficiency in tax collection also evolves a review of the tax exemption policies aiming to evaluate the benefits and adjust them more

efficiently.

In a country-level analysis, structural reform of the tax system is possible. Therefore, this is one topic in which the central government can work as a tool to improve efficiency in tax collection. As examples of performance improvement, the government can enhance the structure of the tax system, focusing on reducing its complexity, changing tax rates, enhancing economic incentives, and reducing the distortions caused by tax exemptions.

There is a direct relationship between tax collection and the health of the economic activity. It means that the higher the GDP, the higher the tax collection tends to be. The magnitude of the response of tax revenues to a GDP boost, however, depends on the composition of the economic expansion due to the structure of the tax system. Therefore, it is highly advisable to have policies of formalization on economic activities to facilitate tax collection, hence improving it.

Regarding plans for efficiency improvements, Curristine et al. (2007) claim that OECD countries have adopted different approaches to reforming key institutional arrangements, such as changing budget practices, and introducing results-oriented approaches to both budgeting and management. This reference, combined with the results provided, might guide the policymakers for upcoming necessary reforms or other changes in budgeting and management of the public sector in Brazil, such as the possibility of remodeling Constitutional Amendment No. 95/2016, which is planned for 2026, allowing to change the restrictions imposed in the limits of public spendings.

Additionally, empirical evidence suggests that decentralization of political power, transferring the spending responsibility to subnational tiers of governments might enhance public sector performance. It might achieve more efficient outcomes by reviewing and changing the rules of Brazilian fiscal federalism. Adam et al. (2012) examine the relationship between fiscal decentralization and public sector efficiency in a country-level dataset for 21 OECD countries.

Regarding the option of solutions that cover efficiency issues in general, Akitoby (2018) states that technology is applied to improve efficiency. Accordingly, simplifying the tax system and curb exemptions and reforming indirect taxes on goods and services might achieve efficiency gains. Regarding the former, the Value-Added Tax (VAT) has also proved to be a potential and efficient revenue booster.

Additionally, since the Brazilian tax system itself, considering exceptions and differentiated regimes that amplify its complexity, is one source of inefficiency in taxation, the government could contribute to the improvement of efficiency by carrying out comprehensive tax reform, prioritizing the solution of the current bottlenecks and obstacles that the current system promotes. Another noteworthy point is the indirect effects of improving efficiency by reforming the tax system over the global competitiveness index, influenced by tax issues, and could positively affect the whole economy.

Afonso et al. (2013) suggest that the efficiency scores might be improved by more transparency and regulatory quality. It is emphasized that these sorts of policies are feasible. However, being feasible differs from being easy to implement. In that regard, Brinkerhoff and Brinkerhoff (2015) highlight the challenge of measuring results and the practical difficulties in achieving a contextual adjustment and accounting for the uncertainty inherently observed in reform processes.

Notwithstanding, we expect that this work contributes to the current national debate regarding economic and political issues, guiding policymakers and lawgivers in terms of public policies based on this framework.

6. CONCLUDING REMARKS

This paper has explored an important issue not only in Brazil but also worldwide, which is the efficiency in taxation. Broadly speaking, the issues aim to enhance the understanding concerning this topic as a whole and also specific issues treated individually, namely, efficiency in tax collection and the possibility to recompose the tax revenue drivers. In that regard, the findings

bring light to a feasible alternative to increase tax revenue without neither losing wellbeing nor distorting the incentives of the productive sector.

Once the Spending Cap Fiscal Regime is already running and that there is a possibility of remodeling it planned for 2026, allowing to change the restrictions imposed in the currently running version, the results provided might also orientate changes to enhance its effects and results. Indeed, efficiency improvements in tax collection, which would likely increase tax revenue, might concern the areas and shares these extra resources would be addressed, whether to reduce the public debt or any other destination the government considers important or necessary.

Moreover, as long as tax reductions work as good incentives for the economic agents, following the good practices the countries around the world have been implementing might help Brazil to boost its economy, hence to recover from the side effects of the Covid-19 pandemic. Therefore, the government should focus on feasible tax policies, considering the structure of public finances and the low level of changes allowed for the current tax system. In this context, it provides one alternative to boost tax revenue by improving the efficiency of tax collection. Additionally, it would allow for reducing tax rates.

The topics covered in this paper represent a small share of the whole issue of efficiency. Therefore, there still is a research agenda full of unsolved research questions. Nevertheless, we expect the findings provided so far might contribute to the current public debate regarding this topic in Brazil and guide policymakers through the policy implications discussed. Finally, although these policy implications might seem hard to implement, one of the main takeaways of this paper is their feasibility to accomplish.

REFERENCES

Adam, A., Delis, M.D., Kammas, P., 2012. Fiscal decentralization and public sector efficiency: Evidence from OECD countries. MPRA Paper No. 36889. Munich Personal RePEc Arquive.

Afonso, A., Romero, A., Monsalve, E., 2013. Public sector efficiency: evidence for Latin America. Discussion Paper No. IDB-DP-279, Fiscal and Municipal Management Division, Inter-American Development Bank.

Afonso, A., Schuknecht, L., Tanzi, V., 2005. Public sector efficiency: An international comparison. Public Choice. 123, 321–347. DOI: 10.1007/s11127-005-7165-2

Agha, A., Haughton, J., 1996. Designing VAT systems: Some efficiency considerations. The Review of Economics and Statistics. 78 (2), 303-308.

Akitoby, B., 2018. Raising revenue: Five country cases illustrate how best to improve tax collection. Finance and Development. 55, 1. Available at: https://www.imf.org/external/pubs/ft/fandd/2018/03/akitoby.htm

Arbel, A., Fialkoff, C., Kerner, A., 2019. Public policy for reducing tax evasion: implications of the Yule–Simpson paradox, Applied Economics Letters. 26 (13), 1092-1099. DOI: 10.1080/13504851.2018.1537471

Barbone, L., Belkindas, M., Bettendorf, L., Bird, R. M., Bonch-Osmolovskiy, M.; Smart, M., 2013. Study to Quantify and Analyse the VAT Gap in the EU-27 Member States. CASE Network Reports No. 116, 127 p.

Bailey, M. J., 1971. National income and the price Level. Mcgraw-Hill, New York.

Barro, R., 1981. Output effects of government purchases. Journal of Political Economy. 89(6), 1086-1121. doi:10.1086/261024.

Barro, R., 1990. Government Spending in a Simple Model of Endogenous Growth. Journal of Political Economy. 98, 103-125.

Beck, M.; Rivers, N.; Wigle, R.; Yonezawa, H. 2015. Carbon tax and revenue recycling: Impacts on households in British Columbia. **Resource and Energy Economics**, v. 41, p. 40–69. http://dx.doi.org/10.1016/j.reseneeco.2015.04.005

Bezerra, A. R., Pereira, R. A. C., Campos, F. A. O., Callado, M. C., 2014. Efeitos de crescimento e bem-estar da recomposição dos investimentos públicos no Brasil. Pesquisa e Planejamento Econômico. 44, 579-607.

Bezerra, A. R., Pereira, R. A. C., Campos, F. A. O., Callado, M. C., 2019. Corruption and Privatization: Macroeconomic and Welfare Effects in Brazil. The Empirical Economics Letters. 18 (5).

Braütigam, D., Fjeldstad, O.H., Moore, M., 2008. Taxation and state-building in developing countries: Capacity and consent. Cambridge University Press, Cambridge.

Brinkerhoff, D.W., Brinkerhoff, J.M., 2015. Public sector management reform in developing countries: perspectives beyond NPM orthodoxy. Public Administration and Development. 35, 222–237. DOI: 10.1002/pad.1739

Campos, F. A. O., Pereira, R. A. C., 2016. Corrupção e Ineficiência no Brasil: uma análise de equilíbrio geral. Estudos Econômicos. 46, 373-408.

Chari, V. V., Christiano, L. J., Kehoe, P. J., 1994. Optimal Fiscal Policy in a Business Cycle Model. Journal of Political Economy. 102, 617-652.

Chari, V. V., Christiano, L. J., Kehoe, P. J., 1995. Policy Analysis in Business Cycle Models, in: Cooley, T. F. (ed), Frontiers of Business Cycles Research. Princeton University Press, Princeton, NY, pp. 357-391.

Chatterjee, S., Ghosh, S., 2011. The dual nature of public goods and congestion: the role of fiscal policy revisited. Canadian Journal of Economics. 44 (4), 1471-1496.

Chen, D., Mintz, J. M., 2015. The 2014 global tax competitiveness report: a proposed business tax reform agenda. The School of Public Policy – SPP Research Paper. 8(4).

Christie, E., Holzner, M., 2006. What explains tax evasion? An empirical assessment based on European data, WIIW Working Paper No 40, 69 p.

Cooley, T. F., Prescott, E. C., 1995. Economic growth and business cycles, in: Cooley, T. F. (ed), Frontiers of Business Cycles Research. Princeton University Press, Princeton, NY.

Curristine, T., Lonti, Z., Joumard, I., 2007. Improving public sector efficiency: challenges and opportunities. OECD Journal on Budgeting. 7(1), 42 p.

Eicher, T., Turnovsky, S. J., 2000. Scale, Congestion and Growth. Economics, New Series. 67(267), 325-346.

Everest-Phillips, M., 2009. State-Building Taxation for Developing Countries: Principles for Reform. Development Policy Review. 28 (1), 75-96.

Ferreira, P. C., 1993. Essays on Public Expenditure and Economic Growth. Unpublished Ph.D. Dissertation. University of Pennsylvania, Pennsylvania.

Ferreira, P. C., Nascimento, L. G., 2006. Welfare and growth effects of alternative fiscal rules for infrastructure investment in Brazil. Ensaios Econômicos, EPGE 604. Fundação Getulio Vargas, Rio de Janeiro.

Freire-Gonzalez, J. 2018. Environmental taxation and the double dividend hypothesis in CGE modelling literature: A critical review. **Journal of Policy Modeling**, v. 40, p. 194–223. https://doi.org/10.1016/j.jpolmod.2017.11.002

Fullerton, D.; Metcalf, G. E. 1997. Environmental Taxes and the Double-Dividend Hypothesis:

Did You Really Expect Something for Nothing? **Working Paper 6199**, NBER Working Paper Series. NATIONAL BUREAU OF ECONOMICS RESEARCH. Sept. 1997.

Gomes, J.W.F., Pereira, R.A.C., Bezerra, A.R., 2019. Efeitos distributivos do aumento nos investimentos públicos em infraestrutura no brasil. Pesquisa e Planejamento Econômico - PPE. 49(2), 165-200.

Gomes, J.W.F., Pereira, R.A.C., Bezerra, A.R., Lucio, F.G.C., Saraiva, A.M., 2020. Efeitos fiscais e macroeconômicos da emenda constitucional do teto dos gastos (nº 95/2016). Nova Economia. 30(3), 893-920. DOI: http://dx.doi.org/10.1590/0103-6351/5235

Goulder, L. H.; Hafstead, M. A. C. 2013. Tax Reform and Environmental Policy: Options for recycling revenue from a tax on carbon dioxide. **Discussion Paper** - Resources for the Future, RFF DP 13-31. Oct. 2013.

Holland, M., 2019. Fiscal crisis in Brazil: causes and remedy. Brazilian Journal of Political Economy. 39(1), 88-107.

Instituto Brasileiro de Geografia e Estatística – IBGE, 2014. Pesquisa Nacional por Amostra de Domicílios (PNAD, 2014): www2.ibge.gov.br/home/estatistica/populacao/trabalhoerendimento/pnad2009/default.shtm.

Instituição Fiscal Independente – IFI, 2020. Relatório de Acompanhamento Fiscal Nº 25. Outubro, 2020: https://www2.senado.leg.br/bdsf/handle/id/578343.

Instituição Fiscal Independente – IFI, 2021. Relatório de Acompanhamento Fiscal Nº 49. Fevereiro, 2021: https://www2.senado.leg.br/bdsf/bitstream/handle/id/584764/RAF49_FEV2021.pdf?sequence=20&isAllowed=y.

Keen, M., 2013. The Anatomy of the VAT. National Tax Journal. 66 (2), 423–446.

Nam, C., Parsche, R., Schaden, B., 2001. Measurement of Value Added Tax Evasion in selected Countries on the Basis of National Accounts Data. CESifo Working Paper No. 431, 16 p.

Organisation for Economic Co-operation and Development - OECD, 2012. Consumption Tax Trends 2012: VAT/GST and Excise Rates, Trends and Administration Issues. 220 p. DOI: https://doi.org/10.1787/ctt-2012-en

Pereira, R. A. C., Ferreira, P. C., 2008. Efeitos de Crescimento e Bem-estar da Lei de Parceria Público-Privada no Brasil. Revista Brasileira de Economia. 62(2), 207–219.

Pereira, R. A. C., Ferreira, P. C., 2010. Avaliação dos impactos macroeconômicos e de bem-estar da reforma tributária no Brasil. Revista Brasileira de Economia. 64, 191-208.

Pereira, R. A. C., Ferreira, P. C., 2011. Impactos Macroeconômicos da Cobrança pelo Uso da Infraestrutura Pública no Brasil. Pesquisa e Planejamento Econômico. 41(2), 183–212.

Pintea, M., Turnovsky, S. J., 2006. Congestion and Fiscal Policy in a Two-Sector Economy with Public Capital: A Quantitative Assessment. Computational Economics. 28, 177-209.

Romer, C. D., Romer, D. H., 2010. The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks. American Economic Review. 100, 763–801.

Santana, P. J., Cavalcanti, T. V., Paes, N. L., 2012. Impactos de Longo Prazo de Reformas Fiscais sobre a Economia Brasileira. Revista Brasileira de Economia. 66, 247-269.

Sokolovska, O., Sokolovskyi, D., 2015. VAT efficiency in the countries worldwide. MPRA Paper No. 66422, Munich Personal RePEc Archive.

Souza Júnior, J.R.C., Santos, F., 2017. Simulações da trajetória da dívida bruta do governo geral (2017 a 2037). Texto para Discussão - TD 2303, Instituto de Pesquisa Econômica Aplicada –

IPEA, Rio de Janeiro.

Turnovsky, S. J., 1996. Fiscal Policy, Adjustment Costs, and Endogenous Growth. Oxford Economic Papers. 48, 361-381.

Uzawa, H., 1961. Neutral Inventions and the Stability of Growth Equilibrium. Review of Economic Studies. 28(2), 117-124.

Endnotes

[1] Tesouro Nacional (Brasil), 2021. Carga Tributária do Governo Geral: https://www.tesourotransparente.gov.br/publicacoes/carga-tributaria-do-governo-geral/2020/114?ano_selecionado=2020

[2] Tesouro Nacional (Brasil), 2022. Carga Tributária do Governo Geral: https://www.tesourotransparente.gov.br/publicacoes/carga-tributaria-do-governo-geral/2021/114

[3] Banco Central do Brasil, 2022. https://www.bcb.gov.br/estatisticas/historicofiscais

[4] Tesouro Nacional (Brasil), 2021. Carga Tributária do Governo Geral: https://www.tesourotransparente.gov.br/publicacoes/carga-tributaria-do-governo-geral/2020/114?ano_selecionado=2020

[5] "The Marginal Effective Tax Rate (METR) is the portion of capital-related taxes paid as a share of the pre-tax rate of return on capital for marginal investments" (Chen and Mintz, 2015).

[6] World Economic Forum, 2018. The Global Competitiveness Index 2017-2018 edition: http://www3.weforum.org/docs/GCR2017-2018/03CountryProfiles/Standalone2-pagerprofiles/WEF_GCI_2017_2018_Profile_Brazil.pdf