Área 1 – Teoria Econômica e Aplicada

EFFICIENCY IN TAX COLLECTION: OVERCOMING THE EFFECTS OF THE COVID-19 PANDEMIC ON PUBLIC FINANCES OF THE CEARÁ STATE

Francisco Germano Carvalho Lucio
Department of Economics, CAEN – UFC, Ceará – Brazil
germanocarvalho@caen.ufc.br
(85) 999966285

Jhorland Ayala Garcia
Agricultural and Consumer Economics – ACE Department, UIUC, IL - US
ja8@illinois.edu

Ricardo A. de Castro Pereira
Department of Economics, CAEN – UFC, Ceará – Brazil
and IPECE
rpereira@caen.ufc.br

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ABSTRACT

The main contribution of this paper is to analyze the efficiency in tax collection as an alternative to overcome fiscal problems left by the Covid-19 pandemic, focusing on the Ceará state. A double analysis is performed. Firstly, it estimates the efficiency in the collection of ICMS and the total revenue for the Brazilian states. Then, it adapts a dynamic CGE model to consider these efficiencies, which is calibrated to represent the economy of the Ceará state. Based on the efficiency estimated, exercises were performed simulating improvements in efficiency levels in two strands, one increasing the efficiency in ICMS collection and the other combining it with an ICMS tax rate reduction. The latter is presented as an empirical demonstration for the axiom of the Compensation of the Tax Collection Drivers, proposed in this paper. Results show that the Ceará state presents one of the highest levels of efficiency in tax collection for both measures. Additionally, an improvement in tax collection efficiency would yield an increase in tax collection, continuously but diminishing over the years. We hope this work contributes to the public debate regarding efficiency in tax collection as a feasible alternative public policy to overcome the fiscal problems.

Keywords: Efficiency. Order-*m* Estimation. Tax Collection. Regional CGE Model.
JEL Codes: C68, H75, R50

RESUMO

A principal contribuição deste artigo é analisar a eficiência na arrecadação de impostos como alternativa para contornar os problemas orçamentários deixados pela pandemia da Covid-19, focando no Estado do Ceará. Para tanto, realizou-se uma análise dupla. Primeiramente, estima-se a eficiência na arrecadação do ICMS e da receita total dos estados brasileiros. Em seguida, adapta-se um modelo CGE dinâmico considerando esse tipo de eficiência, calibrado para representar a economia do estado do Ceará. Com base na eficiência estimada, realizaram-se simulações de melhorias nos níveis de eficiência em duas vertentes, uma aumentando a eficiência na arrecadação do ICMS e outra combinando-a com a redução da alíquota do ICMS. Esta apresenta-se como uma demonstração empírica do axioma da Compensação dos Determinantes da Arrecadação de Impostos, proposto neste artigo. Os resultados mostram que o estado do Ceará apresenta um dos maiores níveis de eficiência na arrecadação para ambas as medidas. Além disso, uma melhoria na eficiência da arrecadação produziria um aumento na arrecadação de impostos de forma continua, mas decrescente ao longo do tempo. Espera-se que este trabalho contribua para o debate acerca da eficiência na arrecadação de impostos como alternativa viável de política pública para contornar os problemas fiscais.

Palavras-Chave: Eficiência. Estimação Order-*m*. Tributação. Modelo CGE Regional.
Classificação JEL: C68, H75, R50.

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1 INTRODUCTION

The COVID-19 pandemic that has plagued worldwide since the beginning of the year 2020 has led several governments both national and local, to declare a situation of emergency, consequently adopting measures that promote social distancing. Therefore, for a few months beginning in March, the main measures imposed restrictions on economic activities, given the fact that not only the workplaces but also the common daily activities usually gather people.

Given the fact that this health crisis has shown impacts in the whole world, a considerable amount of studies has been developed and published so far is already reported in the literature in several different fields. Specifically for economics, for instance, there are works for the economic effects from it (McKibbin and Fernando (2020), Fernandes (2020), and Atkeson (2020)) for financial markets (Zhang et al. (2020) and Ashraf (2020)), for poverty (Sumner et al. (2020), Buheji et al. (2020), and Martin et al. (2020)). For the Brazilian case specifically, these impacts are reported for instance by Domingues, Cardoso, and Magalhães (2020) and Domingues et al. (2020).

Regarding the economic effects in the Ceará state specifically, IPECE (2020a), using an indicator for the trend of the performance in the short-term, the Quarterly GDP, shows that the GDP of the Ceará state in the second quarter of 2020, the period with more severe measures to reduce the speed the virus spreads out, has decreased 14.55% comparing to the same period of 2019. Meanwhile, Brazil presented an 11.4% decrease. Considering the cumulative first semester, this decrease for Ceará represented 7.58%, while Brazil presented 5.9%. However, considering the cumulative from the last four quarters, the decrease is around 2.72% and 2.2% for Ceará and Brazil, respectively. So far the forecast for the economic growth of Ceará’s economy for the year 2020 is -4.5%. It is better than the expectation for the Brazilian economy as a whole. According to IFI (2020), the government itself maintained its projection of a 4.7% decline and the International Monetary Fund (IMF) updated its projection to a retraction by 5.8%. This value is also close to the market expectations estimated by the Central Bank of a 5% drop. Finally, the IFI's fiscal scenarios consider a 6.5% decline, with an improvement bias.

Specifically in terms of the job market, based on the data published by PNAD COVID from IBGE for the period from May to August, IPECE (2020c) shows the estimated level of occupation in Ceará, which is the share of the population aged 14 and over who worked even in some informal occupation, fell from 41.6% in May to 39.9% in August. The estimated participation rate, which is the percentage of people in the workforce in the reference week in relation to people of working age, in turn, went from 45.6% in May to 46.0% in August. The unemployment rate, which is the percentage of unemployed people in the reference week in relation to people in the workforce that week, increased from 8.6% in August to 13.1%.

Revenues fall due to the retraction of economic activity and tax exemptions and deferrals. At the same time, expenditures are rising rapidly to mitigate the effects on the income of the most vulnerable part of the population and the financial situation of smaller companies, besides the increase in spends directly on the health system (IFI, 2020). According to official data from IPECE (2020b), in April 2020 it was observed a significant reduction in the collection of ICMS (Tax on the Circulation of Goods and Services), which is the main source of revenue for the Ceará state government and accounts for approximately half of the current tax collection. It shows it was 36.7% lower than in the same month of the previous year. The biggest drop was in May 2020, with a reduction of 39.4%. Subsequently, in June and July there was a decrease in revenue, but with a lower intensity than in previous months. Considering the four months, which is the period that lasts the policy of social distancing and that it starts to be relaxed, the reduction in the collection of ICMS was approximately 22.7%.

Based on that, the Emergency Aid, implemented by the Complementary Law 173/2020[1] and provided by the Central Government, as well as extraordinary credits for the Ministry of Health are very close to this reduction in tax collection. Indeed, according to IPECE (2020d), the amounts transferred in order to mitigate the effects of Covid-19 outweigh the observed drop in the collection of ICMS. However, it should be noted that the second main source of state revenue, the State Participation Fund (FPE), consists of revenues from the Income Tax and taxes on industrialized products collected by the Federal government and transferred to the subnational units, and that are sensitive to the economic cycle. Indeed, the transfers carried out were lower than the revenue losses for the period in 163 million. In terms of net impacts, it can be concluded that the policies taken by the federal branches, Executive and Legislative, during the health crisis contributed significantly to mitigate their negative fiscal effects.

Even though the compensation from the Central Government has been enough for a while, one must remember there is still an expected reduction in the GDP for the current year of 2020. Hence, there will be reduction in tax collection. Moreover, it should be noted that there is a possibility that the tax collection will not recover quickly after the end of the pandemic period. It means that in the coming months the tax collection at all, not only the ICMS collection, will be at levels lower compared to the previous year.

The very first way that comes up in one's mind to surpass this upcoming and delicate fiscal situation is increasing tax rates. However, in terms of the tax burden, Brazil presents a share of the GDP similar to the average of OECD's members. Official data shows it was around 33.5% of the GDP in 2018, considered as one of the highest tax burdens in the world. Additionally, this amount collected has been not enough to afford public spends and it is facing successive fiscal deficits since 2014, contributing to a continuous enlargement of the public debt. Additionally, according to Romer and Romer (2010), tax increases are highly contractionary. Therefore, it is highly likely that it would worsen the current economic situation hence it is unlikely to be approved in congress.

Based on Brazilian federalism, the way the central government collects and distributes these revenues to the subnational units, this scenario combined with the remaining effects of the Covid-19 pandemic might bring future fiscal problems for the public finances of state-level governments as well. Therefore, an increase in efficiency in tax collection might provide an alternative way to mitigate the remaining effects of the Covid-19 pandemic in public finances.

Based on the described scenario, this paper proposes a potential alternative to solve or at least mitigate this problem. The alternative is increasing the efficiency of tax collection. The literature of efficiency performance in tax collection issues has not been properly explored, even though very recent literature has analyzed the efficiency on taxation, especially looking for explanatory factors (Morrissey et al. (2016), Aizenman and Jinjarak (2018), Cevik et al. (2019)). However, there is a gap in the literature combining efficiency on tax collection and dynamic CGE models, which allow the analysis to cover the whole economy. Therefore, this paper proposes to estimate the efficiency in tax collection for the Brazilian states, focusing on the Ceará state, and apply it in a regional and dynamic CGE model to simulate these sort of policies in the economy of Ceará. Additionally, it also simulates a compensation between an increase in efficiency and a reduction in tax rates.

Concerning the national literature about regional CGE, there are several references. Based on ORANI type models (Dixon et al., 1978; 1982), Guilhoto (1995) developed a model for Planning and Analysis for Agricultural Policies, which works for the State of São

[1] It defines the Federative Program for Confronting the Coronavirus SARS-CoV-2 (Covid-19), which basically suspends the payments of contracted debts between the central government and subnational units, transfers from National funds as financial assistance to the States, the Federal District, and the Municipalities, in the year 2020, to apply in actions to confront the SARS- Coronavirus CoV-2 (Covid-19).

Paulo as well as for Brazil as a whole. Yet, based on Dixon e Parmenter (1996), Haddad (1999) created the first inter-regional CGE model totally operational for Brazil, called B-MARIA (Brazilian Multisectorial And Regional/Inter-Regional Analysis). From it, several other models have been developed such as the B-MARIA-SP (Domingues and Haddad (2002)), the B-MARIA-27 (Haddad (2004)), the B-MARIA-27-IT (Haddad and Perobelli (2005)) and the B-MARIA-RS (Porsse (2005)).

Domingues e Haddad (2002) and Domingues e Lemos (2004) splits Brazil into two regions, namely that, the state of São Paulo and the rest of Brazil. This is way easier than models based on TERM, from Horridge, Madden e Wittwer. (2003), which disaggregates for more regions. Aiming to evaluate the long-term effects of the installation of petroleum refineries in the Northeast region, Ribeiro (2017) creates a dynamic model called the Brazilian Northeast Inter-regional Model - B-NORIM. Fochezatto (2002) and, more recently, Braatz et al. (2015) for the Rio Grande do Sul state, which is both dynamics.

It is emphasized that none of the models presented in these references considers efficiency in the public sector, except for Lucio et al. (2019), however, it refers to a static model. Therefore, this paper aims to contribute to the literature by filling this gap, which means, by creating a dynamic and regional CGE model that considers the efficiency of the public sector in terms of tax collection. Additionally, once the governments influence the other economic agents by incentives, one way the government might take action is by increasing its efficiency level performing its duties, which certainly includes tax collection. Therefore, this approach seems suitable.

This paper is composed of five more sections, beyond this introduction. The following two sections present, respectively, the dynamic CGE model for the Ceará state and the calibration of it. In section four, the efficiency scores are estimated and minor analyses are performed as partial results. In section five, some simulations of changes in efficiency in tax collection are performed and discussed. Finally, the most relevant results are highlighted as well as some policy implications are provided.

2 THE ITERATIVE, RECURSIVE-DYNAMIC, AND CEARÁ'S ECONOMY MODEL OF ANALYSIS – IRACEMA.

The model developed in this paper is based on a recursive dynamic CGE model, from Hosoe et al. (2016). The Iterative, Recursive-dynamic, and Ceará's Economy Model of Analysis – IRACEMA[2] brings forth two major changes compared to its reference model. Firstly, once it was developed for state-level analysis, the foreign sector is divided into two regions, namely that, the rest of Brazil and the rest of the world, as in a static version presented in Lucio et al. (2019), which in turn is based on Hosoe et al. (2010). Although this characteristic is unnecessary for the intended approach, it yields a more realistic model for the type of region is being treated.

Besides, this model can be used as a reference model that considers differences in foreign trade, in which one region is subject to the exchange rate but the other is within a national trade, which in turn can be either a state-level approach or a region using a similar currency such as the European Union. Secondly, for covering the main point of the paper, efficiency parameters are included in the taxation duties of the government. The improvement proposed stands as a contribution not only to the national literature but also to the CGE literature as a whole. The IRACEMA Model is presented in detail in the following sections.

[2] Iracema is a very famous native character, which also names the novel written by the nationwide known writer José de Alencar.

2.1 Productive Sectors

As long as the Iracema Model is dynamics, this feature must be emphasized in this beginning. Thus, the factor endowments, labor, and capital evolve over the periods. The labor endowments grow at the same rate as the population growth (pop), then it is driven by this equation:

$$FF_{LAB,t+1} = (1 + pop) * FF_{LAB,t} \tag{1}$$

Once installed the capital is assumed immobile among the sectors. Let the parameter dep represent the depreciation of capital, the capital stock in sector j in the following period is determined by the combination of the current capital stock combined with new capital, converted from investment ($II_{j,t}$). It can be represented as.

$$KK_{j,t+1} = (1 - dep) * KK_{j,t} + II_{j,t} \tag{2}$$

As a basic and common assumption in CGE models, each sector is a profit-maximizing firm. Therefore, in every period it employs optimal levels of intermediate inputs ($X_{j,i,t}$) and the productive factors ($F_{h,t}$), which are combined into a composite factor ($Y_{j,t}$). Although the production process occurs in one shot, in order to achieve a satisfactory understanding, this conception requires the production to be divided into two stages:

First stage:

$$\max_{F_{h,j,t}} \pi^y_{j,t} = p^y_{j,t} Y_{j,t} - \sum_h p^f_{h,t} F_{h,j,t} \quad \text{s.t.} \quad Y_{j,t} = b_{j,t} \prod_h F_{h,j,t}^{\beta_{h,j}} \tag{3}$$

Second stage:

$$\max_{Y_{j,t}, X_{j,i,t}} \pi^z_{j,t} = p^z_{j,t} Z^S_{j,t} - \left(p^y_{j,t} Y_{j,t} + \sum_j p^{qF}_{j,t} X_{j,i,t} \right) \tag{4}$$

$$\text{s.t. } Z^S_{j,t} = \min\left(\frac{X_{j,i,t}}{ax_{j,i,t}}, \frac{Y_{j,t}}{ay_{j,t}} \right)$$

To make the description easier to understand we omit the index t. The parameter b_j is a scaling coefficient, $\beta_{h,j}$ is a share coefficient of the productive factors, the parameters $ax_{j,i}$ and ay_j are input-requirements coefficients to produce one unit of output (Z^S_j). Finally, the prices of domestic goods, composite factor, and composite good, are respectively represented by p^z_j, p^y_j, and p^{qF}_j.

2.2 Foreign Trade: the rest of Brazil and the rest of the world.

As already known, the Iracema Model represents the Ceará's economy, thus the trade must be computed as at least two different flows, which are to the rest of Brazil and to the rest of the world. Given that the economy of the Ceará state only represents around 2% of the Brazilian economy (IPECE, 2016), it is considered a small region. Combining these characteristics, namely that, an open and small economy, suggests that the Ceará state plays no significant economic impact on its trade partners. Therefore, both prices, export, and import are considered exogenous. The prices are all converted to the national currency by using a marketability margin, which in the case of foreign trade also takes into account the exchange rate.

At this part of modeling the Armington's assumption takes place, according to which all the final demanders, namely that, consumers, sectors, government, and investment goods, acquire not goods directly from the productive sector but rather the Armington's composite good (Q_i^F). It is actually a good composed by imports, coming from the rest of Brazil (M_i^C) as well as from the rest of the world (M_i^W), and local sectorial goods (Q_i^S). This combination is performed in a virtual sector for each one of the i-th Armington's composite good. The optimization problem is represented as:

$$\max_{M_i^C, M_i^W, Q_i^S} \pi_{i,t}^{qF} = p_{i,t}^{qF} Q_{i,t}^F - \left[p_{i,t}^{qS} Q_{i,t}^S + p_{i,t}^{mC} M_{i,t}^C + (1+\tau^m) p_{i,t}^{mW} M_{i,t}^W\right] \tag{5}$$

$$s.t. \quad Q_{i,t}^F = \gamma_i \left(\delta q_i^S \left(Q_{i,t}^S\right)^{\eta_i} + \delta m_i^C \left(M_{i,t}^C\right)^{\eta_i} + \delta m_i^W \left(M_{i,t}^W\right)^{\eta_i}\right)^{\frac{1}{\eta_i}}$$

Again, the time index are omitted. Thus, the p_i^{qS}, p_i^{mC}, and p_i^{mW} are respectively the prices of the goods locally offered, imports from the rest of Brazil and the rest of the world. The following parameters are considered constant, so τ^m is an import tariff, γ_i is a scaling coefficient, and η_i is based on the elasticity of substitution. Finally, δq_i^S, δm_i^C, and δm_i^W are input share coefficients for the quantities abovementioned.

Similarly, it is necessary to analyze the decisions considering the supply side. In each period t, These decisions regards to what is offered to the intern market ($Q_{i,t}^S$) and what is exported to the rest of Brazil ($X_{i,t}^C$) as well as to the rest of the world ($X_{i,t}^W$). It is assumed that the sectors divide the domestic output by using a CET function in which every sector adjusts its output for both consumption, domestic and foreign.

$$\max_{Z_i^S, X_i^C, X_i^W, Q_i^S} \pi_{i,t}^{zS} = \left(p_{i,t}^{qS} Q_{i,t}^S + p_{i,t}^{xC} X_{i,t}^C + p_{i,t}^{xW} X_{i,t}^W\right) - (1+\tau_i) p_{i,t}^z Z_{i,t}^S \tag{6}$$

$$s.t. \quad Z_{i,t}^S = \theta_i \left(\xi q_i^S \left(Q_{i,t}^S\right)^{\phi_i} + \xi x_i^C \left(X_{i,t}^C\right)^{\phi_i} + \xi x_i^W \left(X_{i,t}^W\right)^{\phi_i}\right)^{\frac{1}{\phi_i}}$$

Where p_i^{xC} and p_i^{xW} represent the export prices respectively for the rest of Brazil and the rest of the world. τ_i is a joint tax composed by two taxes, namely that, the τ_i^{ICMS} for the ICMS tax and the τ_i^{OT} for all of the others taxes, including the Federal ones. It is applied on the locally produced good. Additionally, the parameter θ_i is a scaling coefficient, and $\phi_i$is defined by the elasticity of transformation. Similarly displayed in the previous maximization problem, ξq_i^s, ξx_i^C, and ξx_i^W are share coefficients.

2.3 Government

As commonly assumed in CGE models, the government is a tax collector and its consumption is set exogenous but growing at a constant rate. The government collects a direct tax from the household's income (T_H^D), which is imposed in a lump-sum style so that the fiscal balance is achieved. Additionally, it also collects from production, based on the ICMS tax (T_i^{ICMS}) and other taxes combined (T_i^{OT}) and from the imports (T_i^M). The tax rates are constant over time and expressed respectively as τ_H^D, τ_i^{ICMS}, τ_i^{Ot}, and τ_i^m.

In order to cover the efficiency in the public sector, one of the main changes in the original model is the inclusion of parameters of efficiency in every channel of tax collection. Thus, the efficiency parameters associated with the tax rates are $\epsilon_{col,d}$, $\epsilon_{col,icms}$, $\epsilon_{col,ot}$, and $\epsilon_{col,m}$, respectively. Equation 11 shows the total revenue collected in a specific period t. This number already carries within it the efficiency levels coming from all of the sources of collecting.

The government spends its tax revenues in consumption of every sector (G_j^F), which is consumed in a constant ratio $\left(\mu_j\right)$, and savings (S^G). The key equations for the government are expressed by equations from (7) to (12).

$$T_{H,t}^{D} = \epsilon_{col,d}\, \tau_H^D \sum_h p_{h,t}^{f} FF_{h,t} \;\forall\, h,t \tag{7}$$

$$T_{j,t}^{M} = \epsilon_{col,m}\, \tau_j^{m} p_{j,t}^{mW} M_{j,t}^{W} \quad \forall\; j,t \tag{8}$$

$$T_{j,t}^{ICMS} = \epsilon_{col,icms}\, \tau_{j,t}^{ICMS} p_{j,t}^{z} Z_{j,t}^{S} \quad \forall\; j,t \tag{9}$$

$$T_{j,t}^{OT} = \epsilon_{col,ot}\, \tau_{j,t}^{Ot} p_{j,t}^{z} Z_{j,t}^{S} \quad \forall\; j,t \tag{10}$$

$$T_{Total,t} = T_{H,t}^{D} + \sum_j (T_{j,t}^{M} + T_{j,t}^{ICMS} + T_{j,t}^{OT}) \;\forall\, t \tag{11}$$

$$G_{j,t}^{F} \le \frac{\mu_j}{p_{j,t}^{qF}} \left(T_{H,t}^{D} + \sum_j \left(T_{j,t}^{M} + T_{j,t}^{ICMS} + T_{j,t}^{OT}\right) - S^G \right) \forall\, j,t \tag{12}$$

2.4 Savings and Investment

The recursive dynamics are savings-driven so that the allocation of investments among the productive sectors depends on that. The private savings in a period t (S_t^P), coming from the households, follows a propensity to save (ss^P), assumed to be constant, as indicated in the following equation:

$$S_t^P = ss^P \left(\sum_{h,j} p_{h,j,t}^{f} F_{h,j,t} - T_t^d \right) \tag{13}$$

The total savings is composed of the private savings plus the foreign savings, which in this paper is a combination of the difference in trading to the rest of Brazil (S_t^c) and to the rest of the world (S_t^f). This amount of resources is spent on investment goods in each sector ($II_{j,t}$) in order to accumulate capital stock. The allocation of the investment goods follows the sectoral share of operation surplus:

$$p_t^k II_{j,t} = \frac{p_{CAP,j,t}^{f}{}^{\zeta} F_{CAP,j,t}}{\sum_i p_{CAP,i,t}^{f}{}^{\zeta} F_{CAP,i,t}} \left(S_t^P + S_t^c + \varepsilon_t S_t^f\right) \tag{14}$$

Where the parameter ζ represents the sensitivity of investment goods allocation to the capital service price ($p_{CAP,j,t}^{f}$), in other words, it is a weight parameter. The parameter ε_t represents the Exchange rate.

2.5 Households

The households' aggregate consumption function is a Cobb-Douglas type and the constraint of available income composes the optimization process, specified below:

$$CC_t = a \prod_i C_{i,t}^{p\;\alpha_i} \;\; s.t. \;\; \sum_i p_{i,t}^{qF} C_{i,t}^{p} \le \sum_h p_{h,t}^{f} FF_{h,t} - S_t^p - T_{H,t}^{D} \tag{15}$$

Where C_i^p is the private consumption of the sector i, p_h^f and p_i^{qF} are the prices of factors and sectorial goods respectively, FF_h is the endowment of factors. Similar to the description of the sectors, the parameter a is a scaling coefficient and α_i is a share coefficient. Based on the solution coming from this problem, the fictitious objective function, or in other words, the Utility function is given as:

$$UU_t = \sum_t \frac{CC_t}{(1+ror)^{t-1}} \tag{16}$$

2.6 Market Clearing Conditions

A CGE model describes the behavior of all the economic agents. In order to reach the general equilibrium, some assumptions are usually set. Firstly, there is no waste in this economy so that market conditions are imposed to achieve equality between supply and demand in every market. It not only means the market of goods produced by every sector, but it also includes the labor market so that the labor employed in all of the sectors must be equal to the total labor endowment, which grows at a constant rate of the population growth. Given the dynamic characteristic of the Iracema Model, the composite investment goods must be completely set in the sectors as well. Finally, Walras' Law allows us to choose a *numeraire*, one price in which all of the other prices are comparable.

3 CALIBRATION

Most of the parameters and exogenous variables required to run a CGE model are calibrated from a Social Accounting Matrix – SAM, which in turn is composed of an Input-Output table. The SAM disaggregates the Ceará's economy into six productive sectors. The disaggregation level depends on the target analysis, which in this case it is not compromised by a low level of disaggregation. This paper takes the year 2013 as the base year. The sectors considered are shown in the following table.

Table 1: Codes for short denomination of the sectors.

Code	Sectors
S1	Agriculture, including support for agriculture and post-harvest.
S2	Extractive industry.
S3	Transformation Industry, Building, Power Electricity, Water and Sewage, and Others.
S4	Trade and repair of motor vehicles and motorcycles, transportation, storage and mail, accommodation and food.
S5	Private Services.
S6	Management, security, public education and health, and social security.

Source: the authors.

This section also follows close to Hosoe et al. (2016). The calibration process in this dynamic model additionally requires information about the capital stocks employed for each sector. Once the SAM provides data for the capital services, the sectoral capital stocks are estimated by $F_{CAP,j,t} = ror * KK_{j,t}$. Combining it with the sectoral investment data, also available in the SAM, the growth rate can be observed. The deal is that the calibrated growth rate is likely to differ from the stylized fact of a growth rate generally assumed in this sort of CGE modeling known as the Business-as-Usual - BAU path, a set of assumptions that yields a steady BAU growth path at the rate of the population growth.

An adjustment in the investment registered into the SAM, given by the sum of the investments in all the sectors and formalized as $I^{SAM} = \sum_i SAM_{i,INV}$, is required to overcome the difference mentioned in the previous paragraph. The assumed investment to achieve the desired growth rate is given as $I^{Assumed} = \frac{pop+dep}{ror} * FF_{cap}^{00}$, where the parameters pop, dep, and ror are respectively the population growth rate, the depreciation rate, and the rate of returns. The FF_{cap}^{00} is the capital service input observed in the base year. Then, the ratio $adj = I^{Assumed}/I^{SAM}$ adjusts the investment good demand. It, in turn, readjust all the SAM making it compatible to a steady base equilibrium.

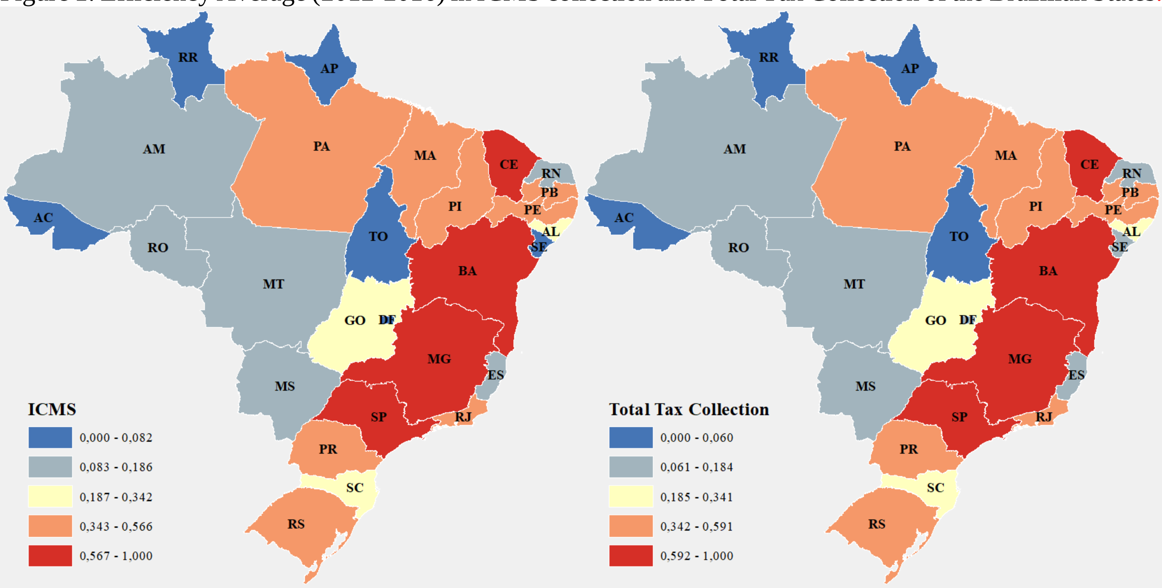
4 TAX COLLECTION EFFICIENCY IN CEARÁ STATE.

This paper follows Cazals et al. (2002) and applies a nonparametric estimator known as Order-*m* efficiency estimation, also well explored in Tauchmann (2012), to calculate the efficiency in tax collection of both ICMS tax and the total tax collection of the Brazilian states. Although part of the analysis regards all states, the focus is the Ceará state, especially because it also works with a CGE analysis. Thus, it uses the level of efficiency performed by the Ceará state as the efficiency parameter. Even though this method is closely related to the widely known nonparametric envelopment estimators, the Data Envelopment Analysis – DEA, it is more robust in terms of extreme values and outliers.

A single input – single output approach is applied for each one of the estimations, namely that, ICMS and Total tax collection, by taking the GDP per capita as the input for both of them and the tax revenue in ICMS and the total tax revenue, which includes all the taxes the state-level government is responsible for collecting, as the outputs. We emphasize that this estimation procedure and the applied approach allow us to perform a specific analysis of efficiency besides using the estimated value for the efficiency parameter in the Iracema model. Once the biggest share of the required parameter comes from the SAM, which uses the 2013 base year, we use the same year for the efficiency parameter in order to make the calibration compatible. However, this analysis covers the period from 2012 to 2016.

As an overview of the estimations, figure 1 shows the efficiency average scores, from 2012 to 2016, for all of the Brazilian states by splitting them into five ranges of efficiency.

Figure 1: Efficiency Average (2012-2016) in ICMS collection and Total Tax Collection of the Brazilian States.

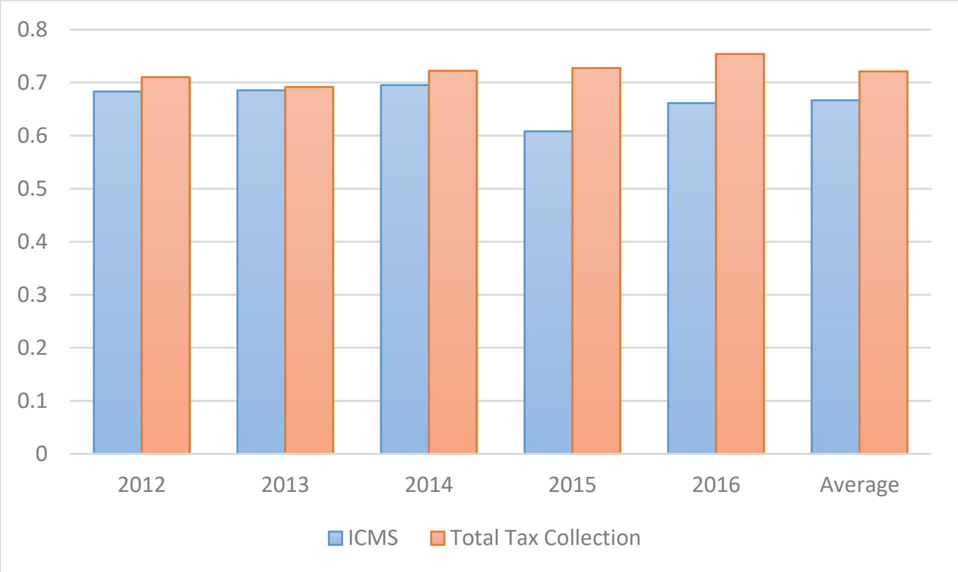


Source: The authors.

Even though this paper focuses on the Ceará state, Figure 1 is important since it provides a quick and visual comparison among the Brazilian states. Worthy to mention that although only two states show differences on the maps, improving from the lower level to the lower-intermediate level in terms of total tax collection *vis-a-vis* ICMS, namely that, the Federal District and Sergipe, they fit in a range and the real scores are actually different. The Ceará state reaches the highest range of efficiency on both measures considered, as so the states of Bahia, São Paulo, and Minas Gerais. On the other hand, the states with the poorest efficiency in tax collection are Acre, Amapá, Roraima, and Tocantins.

Now, to be more specific about the state of Ceará, Figure 2 shows the efficiency scores, year by year as well as the average, for estimations of both ICMS and Total Tax Collection. Based on that, we see it keeps constant its efficiency levels of tax collection, except for a reduction in efficiency collecting ICMS in the year 2015, although it keeps slightly above 0.60, which still fits the highest level abovementioned. Meanwhile, the efficiency of total tax collection presents a trend of increasing.

Figure 2: Efficiency Level in Collection of ICMS and Total Taxes for the Ceará state.



Source: The authors.

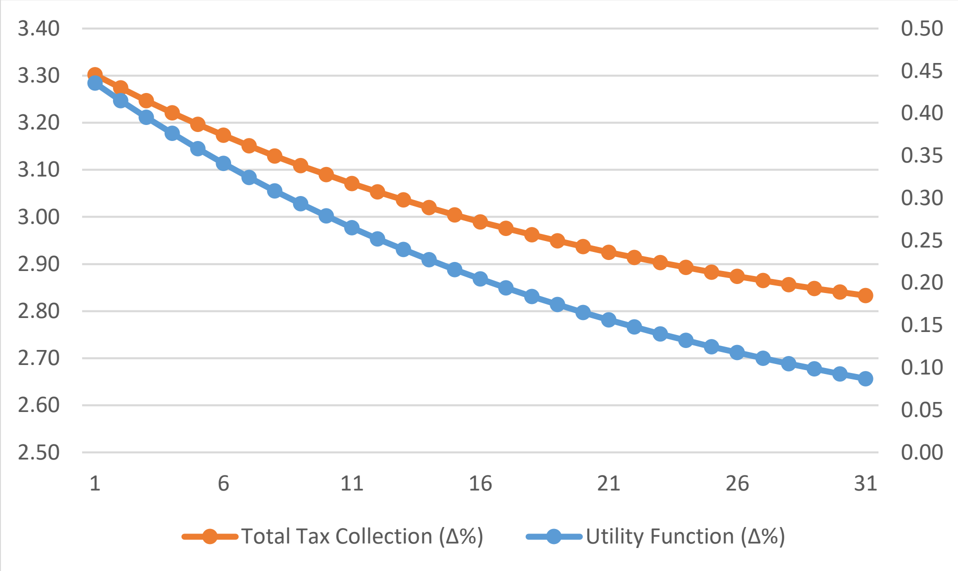
5 SIMULATION EXERCISES AND RESULTS

This paper concerns public sector efficiency issues in tax collection. Therefore, using the Iracema Model it performs simulation exercises by changing the efficiency levels on taxation for the Ceará state. The assumption behind it is that the government enhances its efficiency by collecting taxes. Although efficiency parameters are included in all the sources of tax collection and also that the analysis in the previous section contemplates efficiencies on both ICMS and Total tax collection, aiming to achieve more accurate outputs, the exercises are more specific and simulate changes in efficiency only in ICMS tax. An additional reason for this specific approach is the importance of this tax for the Brazilian states and the control they have over it. Once the Calibration process is based on data for the year 2013, the efficiency level considered refers to the same year, which is 0.685.

5.1 Improving Efficiency in Tax Collection of ICMS.

Firstly, the simulation in this section consists of a positive variation of 10% over the efficiency level of the ICMS collection, which is changing from the base year value of 0.685 to 0.753. This change is moderate and feasible. The concerns on the tax revenue of the Ceará state already expressed in the introduction section requires that the total tax collection changes be contemplated in the first analysis. Besides, considering the common measure usually delivered as a summary of the results in a CGE model, the percentage variation of the utility function, based on consumption, represents the variations in wellbeing. Thus, figure 2 shows the evolution of these two measures over the 30 periods simulated.

Figure 3: Percentage Change of the Total Tax Collection and Utility Function from a 10% Improvement of Efficiency Collecting ICMS tax.



Source: the authors.

On the left axis, there is a total tax collection, which represents a 3.3% variation in the first period and a 2.83% in the last. Given it regards the total tax revenue of the Ceará state, these values can represent a significant volume of resources, especially considering that the efficiency shocks are performed in only one sort of tax rate. On the other side, the right axis shows the percentage change in utility. It starts achieving a 0.44% change and finishes with an insignificant 0.09%, but still positive. The decreasing trend over the years regards the way the variables evolve, considering the population growth rate.

The model applied has a plethora of variables hence the analysis must pick just some of them. Table 2 below contemplates eight variables, which are the Tax Collection of ICMS (T^{ICMS}), the total tax collection of the sector j (T_j), the private consumption (C^p), the GDP (Z), the exports for the rest of the world (Xw) and the rest of Brazil (Xc), and the imports for the rest of the world (Mw) and the rest of Brazil (Mc). All the variations are represented in terms of percentage variations (%). Given the dynamics of the model, it is worth to mention the denomination of the periods. Four periods are displayed, namely that, the first, the fifth, the tenth, and the twentieth, for all sectors. It is worth mentioning that, for simplicity, it is assumed that the efficiency improvements reach all the sectors equally.

Table 2: Percentage Change of Selected Variables from a 10% Increase in Efficiency Tax Collection of ICMS.

Sector/Period	ΔT^{ICMS}	ΔT_j	ΔC^p	ΔZ	ΔXw	ΔMw	ΔXc	ΔMc
$S1P1$	9.91	2.64	0.470	-0.053	-0.196	0.128	-0.150	0.082
$S1P5$	9.78	2.53	0.367	-0.206	-0.437	0.091	-0.381	0.035
$S1P10$	9.66	2.42	0.260	-0.366	-0.689	0.055	-0.624	-0.011
$S1P20$	9.47	2.26	0.103	-0.603	-1.066	0.006	-0.990	-0.071
$S2P1$	9.73	6.35	0.535	-0.145	-0.149	-0.254	-0.103	-0.300
$S2P5$	9.53	6.16	0.462	-0.339	-0.373	-0.360	-0.317	-0.416
$S2P10$	9.31	5.95	0.386	-0.557	-0.626	-0.464	-0.561	-0.529

$S2P20$	8.94	5.59	0.270	-0.920	-1.055	-0.604	-0.978	-0.681
$S3P1$	9.68	2.26	0.502	-0.221	-0.285	-0.132	-0.239	-0.178
$S3P5$	9.56	2.16	0.423	-0.341	-0.439	-0.193	-0.383	-0.249
$S3P10$	9.44	2.05	0.342	-0.464	-0.595	-0.257	-0.530	-0.323
$S3P20$	9.27	1.90	0.226	-0.638	-0.814	-0.351	-0.737	-0.428
$S4P1$	10.07	4.21	0.357	0.014	-0.294	0.409	-0.248	0.363
$S4P5$	9.99	4.13	0.281	-0.070	-0.396	0.347	-0.340	0.291
$S4P10$	9.90	4.05	0.204	-0.155	-0.498	0.283	-0.433	0.217
$S4P20$	9.78	3.93	0.094	-0.275	-0.639	0.186	-0.563	0.108
$S5P1$	10.22	8.01	0.324	0.086	-0.355	0.532	-0.309	0.486
$S5P5$	10.15	7.93	0.262	0.023	-0.409	0.460	-0.353	0.403
$S5P10$	10.07	7.86	0.198	-0.041	-0.463	0.385	-0.398	0.319
$S5P20$	9.95	7.75	0.107	-0.134	-0.539	0.276	-0.462	0.198
$S6P1$	10.00	9.52	0.424	-0.002	-0.216	0.211	-0.170	0.165
$S6P5$	9.95	9.47	0.399	-0.004	-0.137	0.129	-0.081	0.073
$S6P10$	9.90	9.42	0.373	-0.006	-0.054	0.043	0.012	-0.023
$S6P20$	9.83	9.35	0.338	-0.008	0.071	-0.087	0.149	-0.164

Source: The authors. Note: All of the variations represented in the table are percentage variations (%).

As expected, the results show increases in tax collection in ICMS and in the total collected from each sector j at a lower level since ICMS is just a share of it. Additionally, the decreasing trend, already mentioned, is a pattern observed for all variables, given that the population growth is being computed over the years.

However, the response to the shock is different for each sector. Sectors 4 and 5, for instance, start the implementation period with an ICMS collection higher than 10%, which represents the shock. Also, the total collected from a sector depends on the share the ICMS represents on it. For instance, sectors 3 and 1 present the lowest impacts on this variable, with respectively 2.26% and 2.64%. Conversely, sectors 6 and 5 present the highest impacts on the total collected from a sector, with respectively a 9.5% and an 8% increase. The results for the consumption, although seem no significant, are responsible for the changes in wellbeing previously mentioned.

5.2 Adapting the Double Dividend Hypothesis: Efficiency and Tax Rates.

As already mentioned in the introduction, the tax burden in Brazil is high and so it is when it concerns state-level taxes. Although this paper has already shown that both the central and the state-level governments are facing an upcoming period of short and limited resources due to the current scenario, there might still be some margin to apply tax reductions, probably not in a neat way but by applying some sort of compensation.

This compensation could be generated by adapting the double dividend hypothesis and using the recycling revenue issues. The double-dividend hypothesis, from Fullerton and Metcalf (1997), states that create or raise taxes on polluting activities might be able to provide two types of benefits. The first regards an improvement in the environment itself by reducing pollution and the second concerns an improvement in the efficiency of the economy by using the tax revenues collected by the new or higher taxes to reduce other taxes, which is also known as recycling revenues. However, it emphasizes that the validity of this hypothesis must not be taken as applicable in a general matter. Following this specific issue, after performing simulations, Freire-Gonzalez (2018), claims that even though the environmental benefit is almost always achieved due to the fact the changes in taxes also changes the behavior of the economic agents, there is no consensus in the literature, suggesting that it still needs further research.

In this literature, both 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 what alternative tax reductions could be financed by the revenues from an environmental tax. They found that this tax promotes a substantial net revenue and also that the impacts on GDP and wellbeing strongly depend on how this revenue is recycled to benefit the productive sectors.

Roughly speaking, assuming that creating or increasing some tax generates higher tax collection allowing to reduce some other, this process can seem as a composition of revenues. Therefore, it might be possible to compensate the components of a tax collection taking into account the efficiency by collecting. The following axiom formalizes this idea.

Axiom: Compensation of the Tax Collection Drivers.

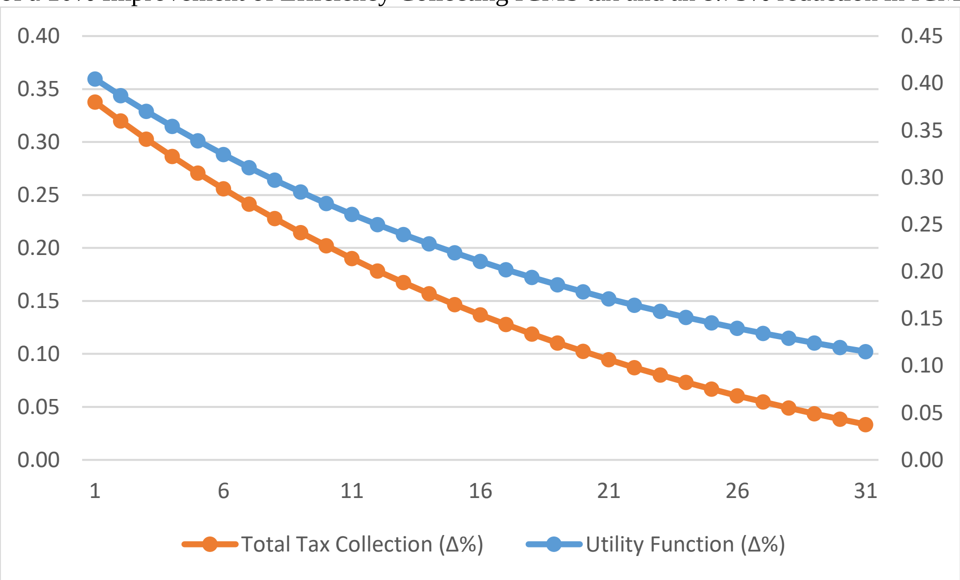
Let the equation for the Tax Collection be $T^i_{j,t} = \epsilon^i_{col,t}\tau^i_{j,t}Z^i_{j,t}$. From an i type of tax, a sector j, and at time t, the components, namely that, $\epsilon^i_{col,t}$, $\tau^i_{j,t}$, and $Z^i_{j,t}$ representing respectively the efficiency level on tax collection, the tax rate, and the incidence base of them, are the drivers of the tax collection $T^i_{j,t}$. For a given level of efficiency, higher than the current value, there is at least one value for the tax rate, lower than the current value, able to yield either the same level or a higher level of the Tax Collection.

The axiom is generally set. Therefore, once included in a CGE model, it is supposed to be able to produce similar conclusions in other variables such as the total tax collection of a government and the wellbeing. The following simulation exercise, using the IRACEMA model proposed in this paper, works as an empirical demonstration of it.

Keeping the modest change in the efficiency of 10% as performed in the previous section and applying the axiom of the compensation of the tax collection drivers to keep the total tax revenues unchanged but still positive over the 30 periods considered, we found that it needs an 8.75% reduction on tax rates. It might be related to the boost effects this sort of incentives bring to the productive sectors.

Due to the population growth inserted on the variation, there is a trend of diminishing effects over the years. So, the combination is chosen in a way there are no negative effects over all the years. This is the reason there are still some positive effects in the beginning. Worthy to mention that the changes in Total collection and Well-being are both lower than 0.4% in the first period after the implementation, as observed in figure 4. Based on that one can assume the percentages chosen fits the axiom.

Figure 4: Percentage Change of the Total Tax Collection and Utility Function from a Combination of a 10% Improvement of Efficiency Collecting ICMS tax and an 8.75% reduction in ICMS tax rate.



Source: the authors.

Similar to the previous analysis, the percentage variation of total tax collection is placed in the left axis and it is around 0.34% in the first period and of 0.03% in the last. On the right axis, there is a percentage change in utility starting at 0.4% and finishing at 0.12%.

Table 3: Percentage Change of Selected Variables from a Combination of a 10% Improvement of Efficiency Collecting ICMS tax and an 8.75% reduction in ICMS tax rate.

Sector/Period	ΔT_{icms}	ΔTs	ΔC^p	ΔZ	ΔXw	ΔMw	ΔXc	ΔMc
$S1P1$	0.325	0.101	0.436	-0.077	-0.361	0.316	-0.382	0.337
$S1P5$	0.204	-0.011	0.313	-0.277	-0.727	0.342	-0.838	0.370
$S1P10$	0.058	-0.146	0.167	-0.517	-1.162	0.371	-1.199	0.409
$S1P20$	-0.110	-0.301	-0.005	-0.796	-1.665	0.402	-1.712	0.450
$S2P1$	0.356	0.248	0.540	-0.127	-0.165	0.074	-0.185	0.095
$S2P5$	0.177	0.069	0.475	-0.364	-0.390	0.034	-0.419	0.062
$S2P10$	-0.060	-0.168	0.395	-0.575	-0.695	-0.015	-0.732	0.022
$S2P20$	-0.385	-0.492	0.296	-0.932	-1.123	-0.068	-1.171	-0.020
$S3P1$	0.542	0.274	0.590	0.084	0.183	-0.100	0.162	-0.080
$S3P5$	0.476	0.194	0.527	0.024	0.128	-0.162	0.099	-0.133
$S3P10$	0.396	0.128	0.475	-0.051	0.056	-0.235	0.019	-0.198
$S3P20$	0.300	0.034	0.398	-0.143	-0.034	-0.321	-0.082	-0.274
$S4P1$	0.460	0.275	0.195	-0.106	-0.725	0.722	-0.746	0.743
$S4P5$	0.392	0.192	0.075	-0.208	-0.902	0.722	-0.930	0.751
$S4P10$	0.311	0.127	-0.015	-0.324	-1.095	0.713	-1.132	0.750
$S4P20$	0.219	0.035	-0.135	-0.450	-1.291	0.684	-1.338	0.732
$S5P1$	0.816	0.745	0.282	0.049	-0.532	0.638	-0.552	0.659
$S5P5$	0.755	0.684	0.214	-0.010	-0.593	0.583	-0.622	0.611
$S5P10$	0.682	0.611	0.160	-0.079	-0.664	0.515	-0.701	0.552
$S5P20$	0.599	0.528	0.083	-0.158	-0.740	0.432	-0.787	0.480
$S6P1$	0.730	0.716	-0.029	-0.009	-1.162	1.158	-1.183	1.179
$S6P5$	0.691	0.677	-0.051	-0.011	-1.099	1.090	-1.127	1.119
$S6P10$	0.645	0.631	-0.075	-0.012	-1.020	1.006	-1.057	1.044
$S6P20$	0.590	0.576	-0.103	-0.014	-0.920	0.901	-0.968	0.949

Source: the authors.

Reducing ICMS, which is the main tax for state tiers of governments, unlike the previous analysis this exercise might shake the economy since there are venues to spread the impacts of this shock making them reverberate both directly and indirectly on a set of different variables. Although in some periods is a negative change in consumption, the aggregated net effect is positive, as seen in figure 4. Remembering the focus here is to guarantee that the Total tax collection seems unchanged, but in a way it still marginally positive, over 30 periods. This type of compensation can surely be applied controlling for any other variable present in the model such as the consumption and/or the tax collected from each sector.

The simulation presented, in which the compensation reaches a minimum positive gain, is some sort of an extreme case. Remembering that the axiom also fits for different levels of compensations that could increase the tax collection. As already shown along the results presented so far, the efficiency gains itself increases the collection, ceteris paribus. Then, reducing taxes but lower than the level required to exhaust the gains coming from the efficiency gains, there will still gather a higher amount collected. Besides, this process is a booster effect in productive sectors provided by lower tax rates. These types of outcomes support the original proposition of Laffer's curve according to which tax rates should be reduced to increase the tax collection efficiency (CEVIK ET AL., 2019).

6 FINAL REMARKS AND POLICY IMPLICATIONS.

The general contribution of this paper is to analyze the efficiency in tax collection as an alternative to overcome or mitigate residual problems on balance the budget in Ceará state left by the Covid-19 pandemic. It required a double analysis, firstly estimating the efficiency in tax collection and secondly adapting a CGE model to consider these important issues. Finally, applying the values estimated into the model, exercises were performed simulating improvements in efficiency levels and also combining it with tax rates reductions.

The current fiscal situation of the Brazilian central government, which was already facing problems to balance its budget even before the Covid-19 pandemic starts and then with all resources it has transferred, plus the damage it has caused in the economic activities, constitutes a strong unfeasibility for raise taxes in the current economic and political scenario. Once tax changes require higher levels of political capital, one would say that it is not a feasible solution to recover public finances.

Conversely, it is worth mentioning that nowadays the alternative proposed in this paper, improve tax collection efficiency, is feasible. It can be performed, for instance, by improving the collecting system technologically such as using electronic invoices. Additionally, according to the Subnational Entities Finance Bulletin, STN (2020), there are possibilities to review significant reducers of collection, namely that, tax waiver and tax expense, which are indirect government expenditures made through the tax system reducing potential revenue. Therefore, there is the possibility to perform continuous reassessments of them and convert them into higher tax collection. It would be a solution to the problem pointed out in this paper.

Moreover, as long as these measures can potentially reverse the effects of the Covid-19 pandemic on the public finances or at least mitigate them, in normal economic scenarios they can also be applied to improve the business environment and boost the economy as development-oriented policies. We emphasize replicability as an important feature of these policies. Therefore, the results shown for the Ceará state might be observed in other subnational units or even in terms of the central government, considering it is responsible for collecting a significant part of tax revenues.

Given that this sort of policy simulated along this paper has the potential to enrich the tax collection and that the effects reverberate for some periods, once the negative effects from the Coivd-19 pandemic have been surpassed, depending on the values, there will still be some positive effects. It might allow other uses for the extra resources such as implement a reduction on the public debt or even increase public investments, which might work as extra positive incentives for the productive sectors, similar to lowering tax rates.

The exercises performed on this paper as well as the results presented might assist the policymakers to enrich their understandings helping them to find out other alternatives in which they can base new public policies. We emphasize that the specificities of the unit and the current economic environment must be taken into account. The most important takeaways are the feasibility and the replicability of these improving efficiency policies.

Finally, although the Iracema model contributes itself to the literature by including efficiency on tax collection in a dynamic and regional CGE model, further extensions of it might be considered. One example is the possibility to split the households into different categories to capture distributive effects and/or include consumption of public goods into the Utility function. It would allow us to include efficiency in the provision of public goods.

Moreover, for further improvements specifically on the efficiency part, performing regressions to verify exogenous drivers for the tax efficiency would be useful for achieve a deeper understanding and orientate the designs of public policies as additional efforts to improve the efficiency of tax collection. This approach, from Simar and Wilson (2007), as a step further of the estimations of efficiency, it performs regressions by taking the estimated scores as the dependent variables.

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