GOODS AND SERVICES TAX DYNAMICS

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ABSTRACT

This paper aims to model the dynamics and the characteristics of the tax over the circulation of goods and services (ICMS) and thus estimate the potential ICMS tax capacity for Brazilian states from a set of socioeconomic variables. As ICMS in Brazil is the main source of public resources of tax origin for Brazilian states, it also defines the maximum capacity of tax collecting by tax authority, given the economic and social characteristics of each state.
First, the ICMS behavior was analyzed and econometric models based on multiple linear regressions using the Ordinary Least Squares Method were built. Statistical criteria were used in the selection of the most appropriate estimation model to estimate the potential ICMS revenue of all Brazilian states. The principle of parsimony was also taken into account to select the simplest model, which still complies with the chosen criteria. The Tax Effort Index for each state was calculated from the ratio between the effective and the potential ICMS revenue, which reveals a valuable tool for revenue performance analysis on this kind of policy making processes. Finally, this study also produced a SD model of the Brazilian good and services tax dynamics to enhance the econometric capability to explain the tax behavior and its interaction with socioeconomic factors.

Keywords: Goods and services tax (ICMS), potential revenue, explanatory variables, method of ordinary least squares, multiple linear regressions, fiscal effort index, tax dynamics.

1) INTRODUCTION

Taxes are the main provision source to finance governments in order to offer public services to society. In Brazil, the main taxes are levied on classic basis such as income, consumption and property. Since Brazil has a federalist system, taxes are collected at the three levels of government: federal, state and municipal.

In general, the Federal Government is in charge of social contributions and income tax, the States for tax on goods, and the Municipalities for tax on services and tax on urban property. Based on this distribution of competencies, in 2014, federal government was responsible for 68.5% of total revenue, while states and municipalities for 25.3% and 6.2%, respectively. The Federal District is the only federated unit that collects both state and local taxes.

In Brazilian tax system, taxes on goods and services account for 51.0% of total tax revenue. Among these taxes, the ICMS state tax is the one that most raises revenues, corresponding to 20.9% of total and 82.8% of state revenues. Therefore, ICMS is the main source of public resource of tax origin for Brazilian States and it will be the focus of this work.

According to Prado (2009), despite the central role of ICMS in the Brazilian taxation system, States are still in a fragile situation. Most of them are in debt, working with limited budget. Additionally, horizontal cooperation among States is precarious, and the "fiscal war" is an illustration of this fact. Indeed, States were the main losers in terms of federal transfers after the Constitution of 1988, due to the expansion of social contributions to finance municipal programs, not shared with States. Over time, state governments concentrated about 40% of its ICMS revenues on the known blue chips - electricity, telecommunications and fuel, with little room for growth nowadays.

Therefore, state tax administrations has no other option then to collect ICMS as efficiently as possible, considering that this tax is the main support of their budgets. Every month, state technicians evaluate tax collection by gathering modality and economic activity, establishing monthly and annual comparisons. However, the assessment of state capacity of collecting ICMS should go beyond the simple analysis of historical collection series, because theses series obviously do not include uncollected components due to the effect of tax expenditures, administrative and judicial litigations, elision and/or evasion. These uncollected taxes constitute the so-called tax gap, which is an object of many tax administration studies. Consequently, knowing the socioeconomic factors that affect ICMS revenue, estimating its maximum tax capacity and how much the effective collection represents in relation to this potential constitute an important management tool for tax administration. This ratio between actual and potential ICMS revenue will be here called Tax Effort Index (TEI).

This study focuses on exploring a set of socioeconomic variables of the 26 Brazilian States and the Federal District, called States from now on, which might explain their ICMS potential revenue, from the structural point of view. Since Brazil is a federation, a good understanding of the ICMS system as a whole and the diversity among its members is vital to develop better policies and orientations.

First, an econometric study will be undertaken by regressions of the ICMS variable on explanatory variables of social and economic nature for the set of States. Thus, potential revenue models using an econometric tool with cross section data with all States (as opposed to a simple temporal analysis) will be constituted for the most recent year in which the variables collected are available, that is 2012. Then, potential revenue will be compared with effective revenue of ICMS to calculate the fiscal effort index of each State.

Knowing that econometric models don't capture the feedback relations between factors, a combination of the econometric study with a system dynamic model will enhance the econometric capability to explain the ICMS behavior and its interaction with the socioeconomic variables studied previously. Therefore, this paper will also explore a system dynamic model based on the relations identified by the econometric study.

Regarding this paper organization, Item 2 will present a discussion, including a literature review of other studies that deal with the same theme. Item 3 will discuss the methodology to be used in the SD and statistical models. Item 4 will analyze the collected variables that can be used as explanatory variables in the SD and estimation models of potential ICMS tax capacity as well as the behavior analysis of explanatory variables in relation to ICMS. Item 5 will test tax capacity models using the econometric package Gretl (Cottrell and Lucchetti, 2016), and the most appropriated model will be selected. Item 6 will discuss results obtained for the potential ICMS revenue using the selected model as well as results for the fiscal effort of each State. Item 7 will explore a SD model of the ICMS tax capacity and finally, Item 7 will present final conclusions.

2) DISCUSSION

The potential revenue of a particular country or state is the maximum revenue that the government would be able to raise, given their socioeconomic conditions, as well as the legal framework of their taxes. Hence, there are two concepts of potential tax capacity, one from the legal and the other from the structural point of view, according to Viol (2006).

The legal potential tax capacity is related to what the government demands from taxpayers based on current tax legislation. The potential revenue would then be that maximum possible revenue resulting from the complete application of the current tax system. The taxable basis predicted in the legislation and current rates to be applied should be considered to measure the legal potential. This is the deterministic method of measuring tax capacity introduced by Carvalho et al (2008).

As for the structural potential, there is less clarity in their outlines and greater difficulty in their measurement. Its estimate is made using econometric models, where the tax becomes the dependent variable of other explanatory variables that reflect the socioeconomic characteristics of a given country or state. There are several literature works that estimate the potential tax capacity considering this structural approach, both internationally and in Brazil.

From the concept of potential tax capacity, one can derive the concept of Tax Effort Index (TEI), or degree of effectiveness, according to some authors. This index is calculated from the ratio of tax revenue, which effectively enters in the public coffers, and the potential revenue, which is estimated by an appropriate structural econometric model. The TEI is used to make comparisons of fiscal effort among countries, as well as among federal units of a given country.

At the international level, many authors have studied variables and tax capacity models of countries. Using cross-section data in 1964, Lotz and Morss (1969) were the first authors to confirm the positive influence of per capita income and degree of openness of economy. Shin (1969) discussed the significance of per capita income, agricultural product and population growth variables in the analysis of cross-section data. Chelliah (1971) showed that ratio of extractive industry product variable was highly significant, degree of openness was significant and per capita income was not significant. Bahl (1971) confirmed the significance of the agricultural product and the mining industry product, and the tax capacity related negatively with the first and positively with the second. Tait, Grätz and Eichengreen (1979) updated the results of Lotz and Morss, as well as Chelliah using cross section data in 1974, and they concluded that the variables of the most explanatory power were mining industry product and degree of openness. Mann (1980) studied the tax capacity of Mexico, using time series, and he concluded that degree of openness, per capita income and agricultural products were significant at certain periods of time while only per capita income was significant and inversely related to tax capacity at more recent time. Piancastelli (2001) used both cross section data with the average for the period 1985-95, as well as panel data, concluding that for the total sample studied, per capita income and degree of openness of economy were significant. However, when the sample was divided into low and middle income countries, he found that only degree of openness became significant for the low income group while agricultural and industry products influenced tax capacity negatively and positively, respectively, for the middle income group. Cafe (2003) estimated tax capacity of industrialized countries and Latin America countries, concluding that per capita income and degree of openness were significant and positively related to tax capacity of the full sample of countries, while for separated groups, there was an improvement in the linear adjustment when the agricultural product variable was added to the model.

Several studies establish comparisons among the tax capacity of the Brazilian States. Reis and Bianco (1996) used production function models with panel data for the years 1970, 1975, 1980, 1985 and 1990, obtaining expected results for GDP, urban population and inflation. Marinho and Moreira (2000) estimated the potential tax capacity of the Northeast Brazilian States for various taxes in the period between 1991 and 1996, also using models of production function with panel data, obtaining significant and direct relationships between ICMS and per capita income, urban population and degree of urbanization, and negative relations with exports and inflation. Vasconcelos *et al* (2006) used panel data from 1986 to 1999 to estimate the potential tax burden of Brazilian States, concluding that industry and service products and GDP per capita were significant and they had positive signs as expected. Carvalho *et al* (2008) estimated the Amazon States tax capacity between 1970 and 2000, in the census years, also using production function models with panel data and they concluded that the economic and demographic variables used in the model were important to access potential revenues of States. However, they obtained a negative not expected sign for industryl product and a not significant relationship. Cafe (2011) estimated the potential tax capacity of Brazilian States in the 2003-2007 period, using linear regression models, and she concluded that GDP, population and industry variables were positive and significant.

3) SYSTEM DYNAMICS MODELING COMBINED WITH STATISTICAL METHODS

The study considered many variables found in the literature that could affect the tax capacity like the Gross Domestic Product (GDP), which measured economic development stage; Exports and Imports, which measured degree of openness; Sector Products (added-value indices) that measure the degree of industrialization and urbanization; and population size. Many other variables such as level of economic inequality (Gini Index), debt (Default Rate), employment (Formal Jobs) and size of the private sector, may also influence state tax capacity and they will be also considered in this study. Figure 1 shows a preliminary causal loop diagram that represents the relations between state tax capacity and its explanatory variables.

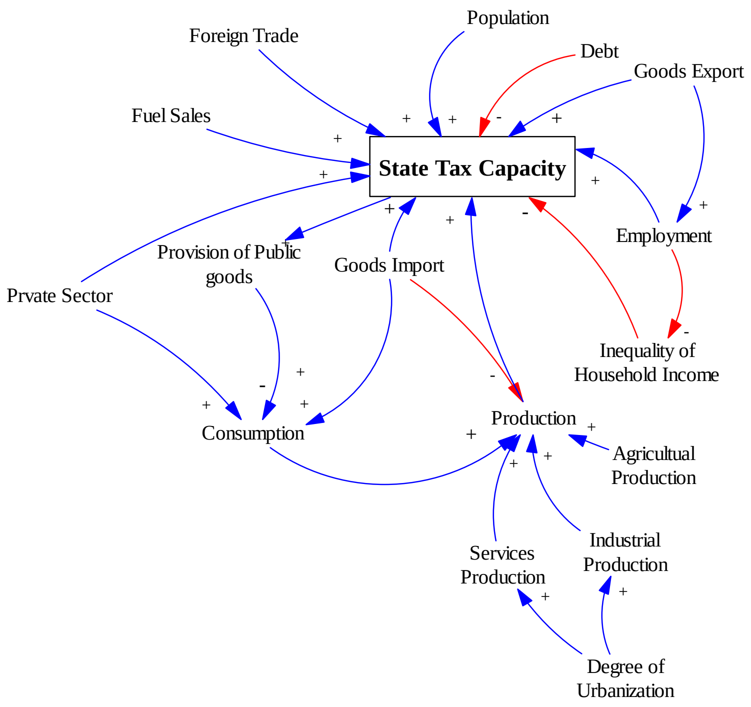

Figure 1: ICMS State Capacity Preliminary Causal Loop Diagram

The analysis of variables took into account interventions and expected signs, as well as level of correlation among them, always considering specific economic and tax aspects of Brazilian states. An explanation of the methods, besides the analysis of each variable and concerns about their interrelation are shown below.

Multiple linear regression models and the method of Ordinary Least Squares (OLS) were used to estimate the potential ICMS tax capacity of Brazilian States. For that, the potential revenue y_i of each State was estimated by the following equation, according to Wooldridge (2010):

$$\hat{y}_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \ldots + \beta_K x_{Ki} + \mu_i$$

onde,

$\hat{y}_i$ - Estimated value for ICMS revenue of each State;

i - Index which represents each State (from 1 to 27);

K - Index which represents the number of explanatory variables;

x_{Ki} – Explanatory variable K of State i;

β_K – Parameter to be estimated for each explanatory variable K;

β_0 – Intercept.

The value $\hat{y}_i$, calculated by this equation, estimates the actual value y_i of potential ICMS revenue for each State. The difference between the estimated and the actual value is represented by a residue μ_i. Therefore:

$$\mu_i = y_i - \hat{y}_i$$

Where,

$\hat{y}_i$ - Estimated value of potential ICMS revenue of each State;

y_i - Actual value of ICMS revenue of each State;

μ_i - Residue of the State index i.

A vector of β parameter (one parameter β_K for each explanatory variable) must be chosen in order to make the smallest possible error in the estimation of the ICMS potential revenue y_i. The estimations of $\boldsymbol{\hat{\beta}}$ is accomplished by solving a set of overdetermined normal equations, which have the following solution:

$$\boldsymbol{\hat{\beta}} = (\mathbf{X}^T\mathbf{Y})^{-1}\mathbf{X}^T\mathbf{Y}$$

Where,

$\mathbf{X}_{27 \times (K+1)}$ is the design matrix with all measured values of the explanatory variables. The lines correspond to the index of each State, and the columns correspond to the index of each explanatory variable.

$\mathbf{Y}_{27 \times 1}$ is the column vector with measured values of ICMS revenue of each State.

$$\mathbf{Y_{27x1}} = \begin{bmatrix} \boldsymbol{y1} \\ \boldsymbol{y2} \\ \dots \\ \boldsymbol{y27} \end{bmatrix}$$

After the estimation of β parameters, the following tests were applied:

1) **Reset Test** of Ramsey regression specification error, as in Wooldridge (2010), especially for omission of variables. This test includes quadratic and cubic terms in the model, and it verifies if the coefficients of these terms are significant, via F test:

Ho: $\beta_5 = \beta_6 = 0$
H1: $\beta_5 \neq 0$ or $\beta_6 \neq 0$
If Ho is rejected, the model is poorly specified.

2) **Breusch-Pagan Test** of heterocedasticity, as in Wooldridge (2010). This test checks if the variance is affected by some independent variables (μ^2 x β) via F test:

Ho : $\beta_1 = \beta_2 = \beta_3 = ... = 0$
Ho is the null hypothesis of homocedasticity.

3**) Variance Inflation Factors (VIF)** where values above 10.0 may indicate a multicolinearity problem, as pointed by Miloca S. and Conjo P. (2011). If a variable is a linear combination of others, the fit degree R^2 tends to 1.0, since VIF is given by:
$FIV = 1/(1-R^2)$
if $R^2 \to 1$, $FIV \to \infty$

In this study, Gretl and Vensim softwares were used for analysis and selection of the most appropriate model in statistical terms, as well as for running the tests presented above.

4) ANALYSIS OF SOCIOECONOMIC VARIABLES

Several socioeconomic variables were collected for all Brazilian States, which may serve as explanatory variables to estimate the potential ICMS tax capacity for the year 2012. Table 1 consolidates this information.

Figure 2 presents a preliminary graphic analysis of ICMS, the dependent variable of the model. A compensation factor of 1/3 was applied to ICMS data from São Paulo State, in order to avoid distortions. São Paulo is clearly an outlier, with production index and tax revenues way beyond the Brazilian average. The same compensation factor will be applied to the variable population and to all those variables related to the economic performance of São Paulo (GDP, Ag_P, Ind_P, Serv_P, Fuel, X and M).

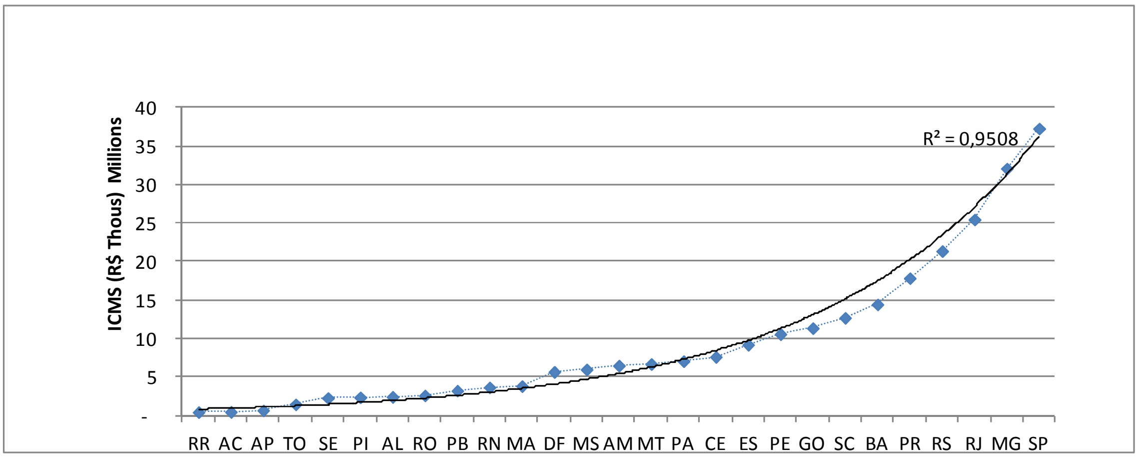

Figure 2 – ICMS revenue in R$ billions versus Brazilian States ordered by ICMS revenue, considering one third of São Paulo ICMS revenue.

From Figure 2, the ICMS revenue curve of Brazilian States follows an exponential trend with degree of adjustment R^2 of 0.95. Then the variable logarithm will be used for the linearization of the model.

Table 1 – Socioeconomic variables to estimate potential ICMS tax capacity.

Variables	Initials	Units	Source	Explanatory Notes
Tax over the Circulation of Goods	ICMS	R$ (thousands)	CONFAZ	Current market prices
Gross Domestic Product	GDP	R$ (millions)	IPEA/IBGE	Current market prices
Economically Active Population	EAP	Individuals	IBGE	Projections (1992 to 2009 data)
Agricultural Product	Ag_P	R$ (millions)	IBGE	Gross Added Value -current market prices
Industry product	Ind_P	R$ (millions)	IBGE	Gross Added Value -current market prices
Service Product	Serv_P	R$ (millions)	IBGE	Gross Added Value -current market prices
Gini Index	Gini	Index	IBGE	Inequality income distribution
Fuel Sales	Fuel	m^3	ANP	Distributor sale
Exports	X	US$ (thousands)	BCB/MDIC/Secex	Foreign trade
Imports	M	US$ (thousands)	BCB/MDIC/Secex	Foreign trade
Formal Jobs	FJ	Units	BCB/MTE	(Admissions - layoffs)
Default Rate	DR	Percentage	BCB	In credit operations
Proxi for Private Sector	PP	Proportion	RFB	(Private sector contributions)/income tax)

The correlation level between the dependent variable (ICMS) and each explanatory variable was studied. Table 2 shows the values of linear correlation (LC), which serves as an indication of what variables should be included in potential tax capacity models.

Table 2 – Linear correlation between ICMS and explanatory variables represented by their initials according to Table 1.

Variables	LC
GDP	0,959
EAP	0,920
Ag_P	0,587
Ind_P	0,891
Serv_P	0,979
Gini	-0,460
Fuel	0,960
X	0,873
M	0,867
FJ	0,624
DR	-0,140
PP	0,035

The linear correlation values vary in magnitude between 0.035 and 0.979. The positive sign points to a direct linear correlation while the negative sign for an inverse linear correlation. All variables will be regarded as potential explanatory variables in the ICMS tax capacity models.

Table 2 shows that the relationship between ICMS and variables which indicate economic performance were positive and high, above 0.85, except for Agriculture Product (Ag_P). For illustration purpose, Figure 3 shows the relationship between ICMS and industry product (Ind_P) with positive linear correlation of 0.89. This positive relationship was expected, as pointed out by Varsano et al (1998).

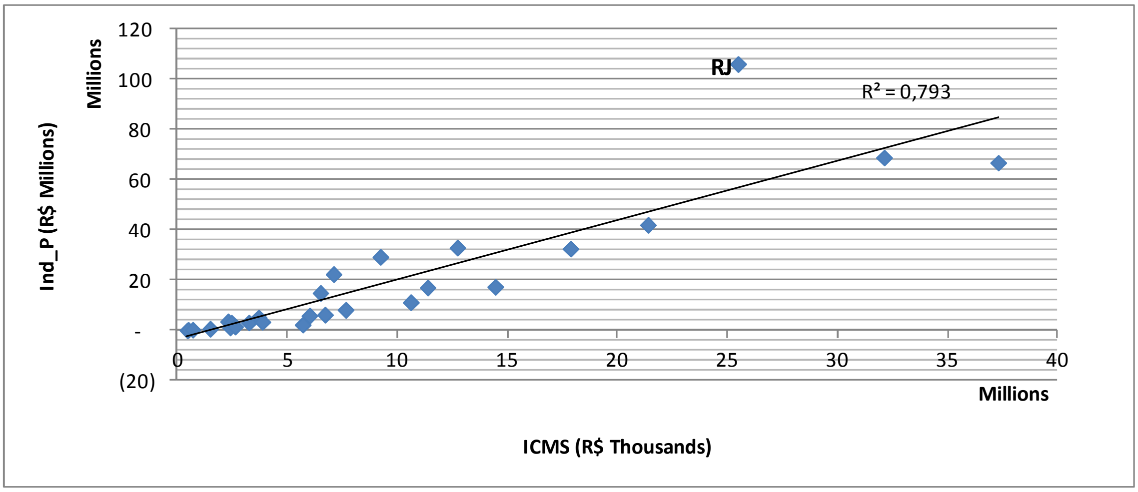

Figure 3 – Industry product (Ind_P) in R$ trillions versus ICMS in R$ billions of Brazilian States. The blue points are observations for each State. The continuous line represents a linear model adjusted to the observations with R^2 = 0,793. Notice that Rio de Janeiro State is an outlier.

Rio de Janeiro State is an outlier in the relationship between ICMS and Industry Product, due to the oil production industry. Although the State is a major oil producer, taxation is at destination in interstate operations with lubricants and oil fuels, according to the Brazilian Federal Constitution. Thus, ICMS is charged where consumption occurs, which induces a gap between industry product and ICMS revenue in Rio de Janeiro.

The curves of variables related to economic activity plotted against Brazilian States ordered by ICMS revenue follow an exponential trend, which suggests the use of logarithm of these variables in order to obtain linear relationships in the estimation models of potential ICMS tax capacity. All of these variables, with the exception of Agriculture Product, have good explanatory power of the dependent variable ICMS, since the values of fit degree R^2 are above 0.75.

The level of linear correlation among the variables that are indicative of economic activity was also studied and a high correlation was found, as expected. Thus, the models will contain only one indicative variable of economic activity to avoid colinearity between explanatory variables, respecting this classic hypothesis of the method.

The Economically Active Population (EAP) also has a strong correlation to ICMS, with correlation index of 0.92. The positive relationship is obviously expected: the larger the population, the greater the tax capacity, as cited by Varsano et al (1998). The EAP curve has also an exponential behavior, shown in Figure 4, also indicating the use of its logarithm for the linearization of the estimation model.

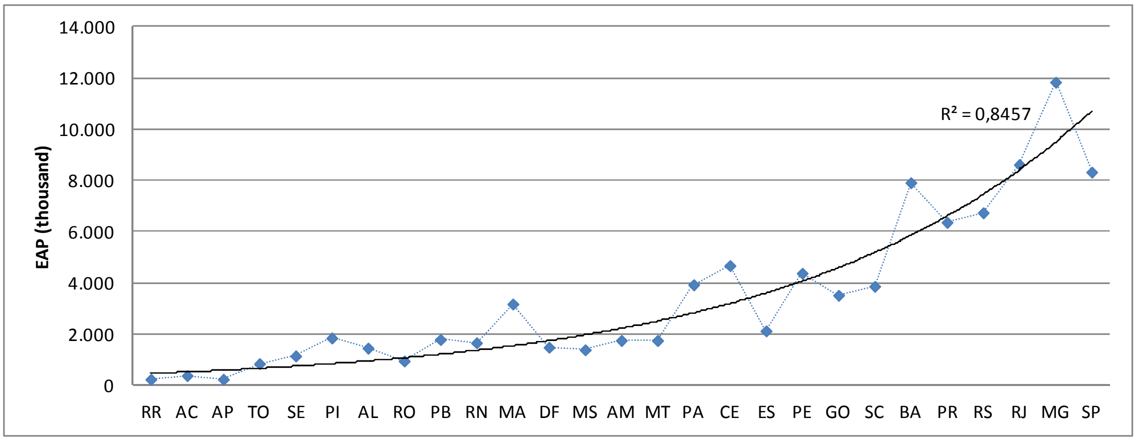

Figure 4 – Economically Active Population (EAP) in thousands of individuals versus Brazilian States ordered by ICMS revenue. The blue points represent the observations for each State. The continuous line represents an exponential model adjusted to the observations with R^2 = 0,846.

The degree of adjustment R^2 of 0.846 of ICMS versus EAP indicates a good explanation power of EAP variable in the ICMS potential estimation model.

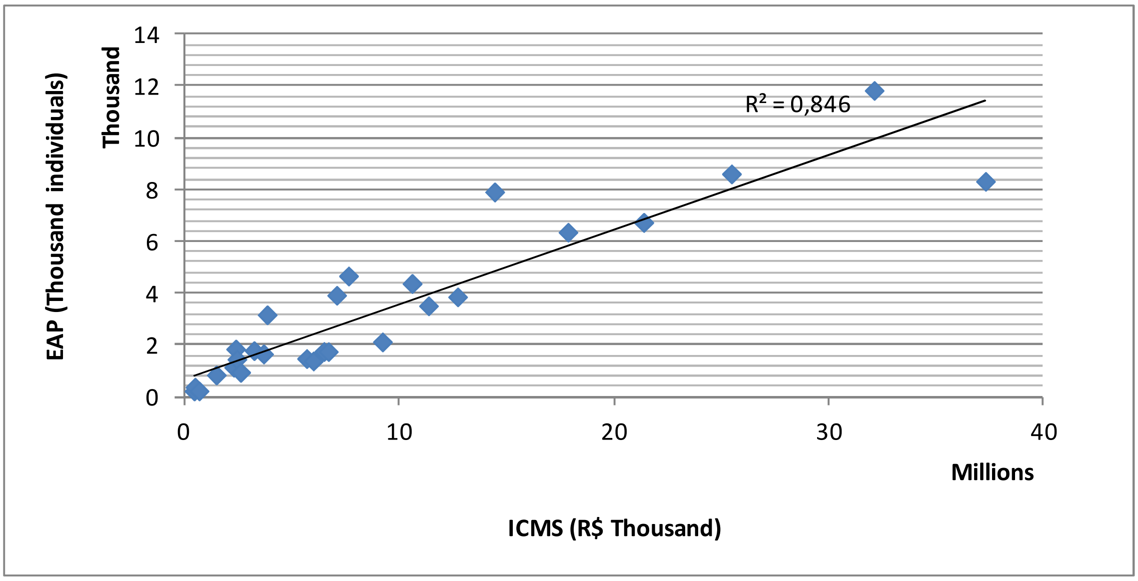

Figure 5 – Economically Active People (EAP) in millions of individuals versus ICMS in R$ billions of Brazilian States. The blue points are the observations for each State. The continuous line represents a linear model adjusted to the observations with R^2 = 0,846.

Gini index measures the degree of inequality in the distribution of per capita household income among individuals. Its value can vary theoretically from zero, when there is no inequality, to one when inequality is maximum. The correlation coefficient found between ICMS and Gini index is -0.46, indicating an inverse relationship between these two variables.

There is a positive linear correlation of 0.87 between ICMS and both export (X) and import (M) variables, as shown in Table 1, despite the Complementary Law No. 87/1996, known as Kandir Law. Although this Law exempts from taxation goods and services for export, increase in ICMS revenue following both exports and imports was observed. This positive correlation is probably due to the direct effects of imports, since ICMS is levied on imported goods, and secondary effects of exports, as they move the economy, creating jobs and increasing income to purchase goods.

Varsano et al (1989) argue in favor of an inverse relationship between potential ICMS revenue and trade balance, and consequently exports. On the other hand, Vasconcelos et al (2006) point out that international trade is an important source of income, especially in developing countries.

There is a good degree of adjustment between ICMS and foreign trade variables, with R^2 greater than 0.75. In addition, X and Y curves tend to a 2nd degree polynomial equation, suggesting the use of square root of these variables in order to linearize the models. Figure 6 illustrates the curve of Imports (M).

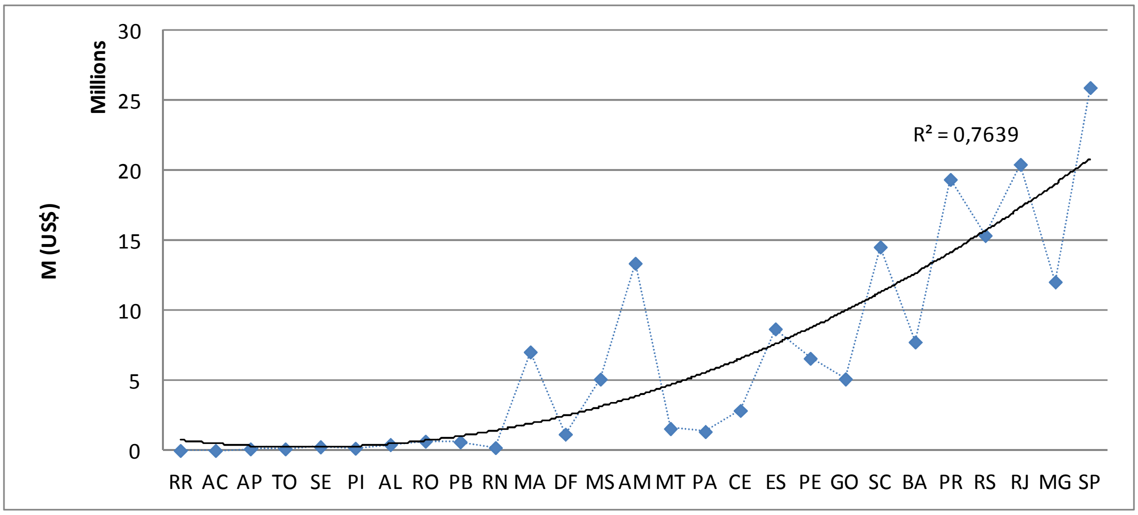

Figure 6 – Imports of goods (M) versus Brazilian States ordered by ICMS revenue. The blue points are the observations for each State. The continuous line represents a 2nd degree polynomial model adjusted to the observations with R^2 = 0,764.

The variable of formal jobs generated in the year (FJ) is the difference between admissions and layoffs in 2012. This variable is an indirect indicator of economic performance and therefore establishes a positive correlation with ICMS of 0.62. However, the ICMS versus FJ showed a degree of adjustment R^2 of less than 0.5, indicating that FJ has a low explanation power in the ICMS estimation model.

According to Table 1, the variable default rate on credit operations (DR) has a negative correlation with ICMS of -0.14, indicating an inverse relation but probably, DR has a low explanatory power of the variable ICMS, confirmed by the low degree of adjustment R^2 of 0.02. The negative sign of this correlation was expected, since the default rate is indicative of debt, which is related to low family income and low consumption power.

The proxy of private sector (PP) used is the ratio between private sector contributions and income tax. This variable has a low correlation of 0.03 with ICMS, which induced an extremely low degree of adjustment R^2 of 0,001 in the linear relation between ICMS and PP. Despite the expected positive signal at first, as services offered by the public sector are not in the tax incidence field, Varsano et al (1989) argued for a negative sign. According to them, a greater participation of the States in the provision of services, such as education and health, will induce a greater tax capacity, since this provision would replace purchase of such services in the market, freeing up more resources for private consumption.

5) SELECTION OF ICMS TAX CAPACITY MODEL

Several models have been tried with Gretl program (Cottrell and Lucchetti, 2016), including the explanatory variables described in the previous section, and containing only one variable of economic performance. The goal in any attempt was to obtain a model that contains all significant variables to at least 10%, expected signs and satisfactory behavior in Reset, Breush-Pagan and colinearity tests.

The F statistic showed significance at 1% of the set of variables in all tested models, indicating that the set of explanatory variables can effectively be used to estimate the dependent variable (ICMS). However, only one model was able to meet the conditions placed above and therefore, this one was selected.

The selected model includes industry product (Ind_P), population (EAP) and import (M) variables, significant to 1%, 1% and 10%, respectively, with expected signals, and intercept at 1%. The model showed good fit and good results in all tests. However, considering that the coefficient obtained for M variable was very small (0.0001), and using the principle of parsimony, this variable was removed from the model. Thus, the multiple regression model finally selected for the estimation of potential ICMS tax capacity includes industry product and population variables. Table 3 presents the selected model.

Table 3 – Selected Model for Potential ICMS Tax Capacity Estimation

ln(ICMS) = 5,840 + 0,405ln(Ind_P) + 0,433ln(EAP)				
n = 27 observations (Brazilian states)				
	coefficient	**standard error**	**t statistics**	**p-value**
const	5,83989	0,458635	12,73	3,63e-012 ***
l_Ind_P	0,404767	0,0720932	5,614	8,85e-06 ***
l_EAP	0,432982	0,124151	3,488	0,0019 ***
R2 adjusted	0,950665			
F(2, 24)	251,5047	**F (p-value)**	7,96E-17	

The estimated coefficients are indeed measurements of elasticity, since it is a double logarithmic model. Thus, controlled for the EAP variable, 1% of Ind_P increase represents an ICMS increase of 0.405% for the set of States. Similarly, controlled for the Ind_P variable, 1% of EAP increase represents an ICMS increase of 0.433%.

6) RESULTS

Figure 7 shows the comparison between logarithm values of effective ICMS and ICMS values estimated by the selected model. The estimation has an average deviation of 0.004 or 0.05% of logarithm of effective ICMS.

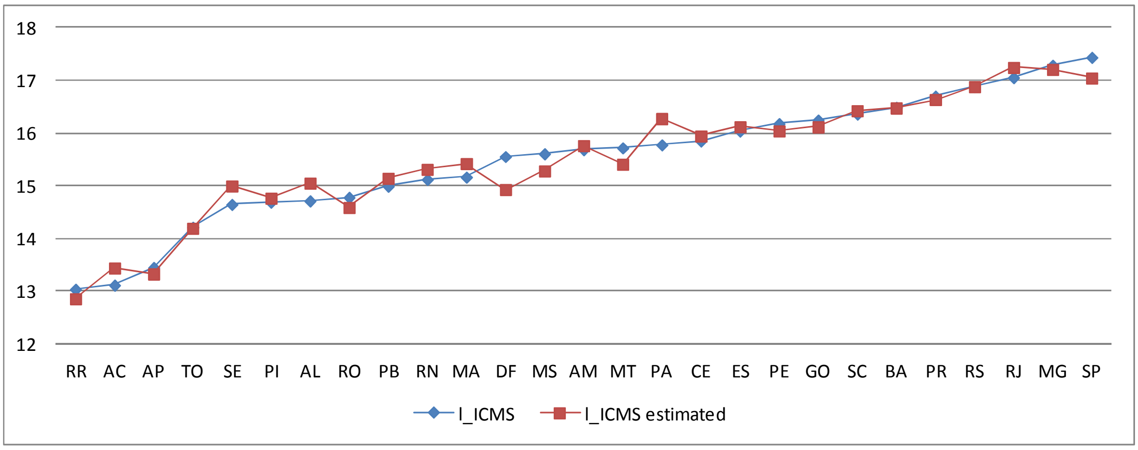

Figure 7 – Comparison between logarithm of effective ICMS (in blue) and logarithm of ICMS values estimated by the model (in red).

The Tax Effort Index (TEI) was calculated from the estimated ICMS tax capacity. The largest deviations obtained between actual and estimated ICMS are reflected in this index since it is defined as the ratio between effective and potential ICMS. Figure 8 shows TEI curve for Brazilian States, whose index values range between 0.61 and 1.86. Index values below 1.0 indicate that States can increase its ICMS revenue, while values above 1.0 indicate that States collect higher revenue than what would be expected from their bases.

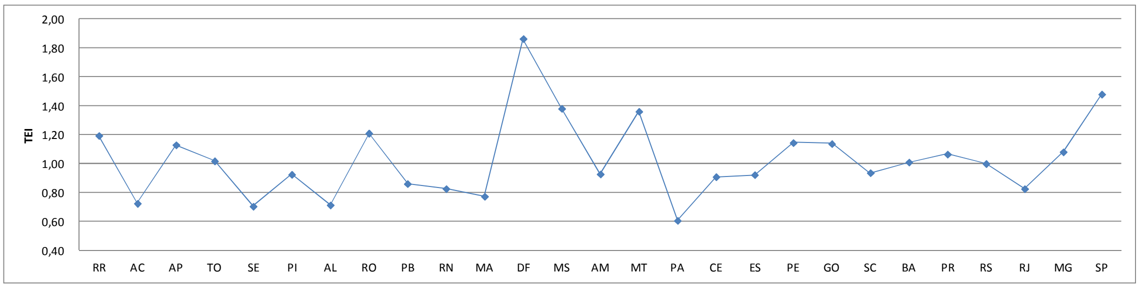

Figure 8 – Tax Effort Index of Brazilian States (base year 2012).

From Figure 8, 14 States obtained TEI equal to or above 1.0, and 13 States below 1.0. Distrito Federal, São Paulo and Mato Grosso do Sul presented the highest TEI of 1.86, 1.48 and 1.38, respectively. On the other hand, Pará, Sergipe and Acre TEI were the smallest of 0.68, 0.70 and 0.72 respectively.

There is a natural difficulty to accept higher rates than 1.0. Those values can be explained by the fact that the method (OLS) gives an average curve that minimizes the square sum of the errors, separating points above and below the average curve. Consequently, for some States, this may lead to an overestimation of their potential revenue. A second possible explanation is related to the State law that provides effective revenue greater than the one derived from the State economic bases. Finally, there are situations that can increase exogenously the effective collection.

In 2012, the base year of the study, there were exogenous factors such as an anticipated ICMS on electricity, as well as, incremental revenue arising from a credit recovery program that may explain the high TEI of 1.86 obtained by Distrito Federal. The case of Mato Grosso do Sul can also be explained by an exogenous factor to its tax capacity, which granted an injunction that guarantees the ICMS tax on the Bolivian natural gas import operations to the State.

On the other hand, Pará had the lowest TEI among the Brazilian States, related to the fact that Pará is a major producer and exporter of iron ore and aluminum, which increases its industry product, but this activity is not taxable by ICMS. Similar case occurs with Rio de Janeiro and Sergipe. Both States are oil producers, which increase their industry product, but ICMS taxation on oil and its derivatives at interstate operations occurs in the destination State, not in the producer State.

7) GST TAX DYNAMICS

These econometric analyses above gave insights to identify the variables that work as stocks and to produce the following stock and flow diagrams to represent the GST dynamic model and its interrelations. This diagram considers the actual structure of the model, including stocks, flows and external inputs (Sterman, 2000).

In the GST tax dynamic model, there are three majors stocks identified by the selected econometric model: state tax reserve, originated by the state tax revenue collected – the dependent variable of the econometric model, industry product and population, both significant explanatory variables. The following topics will present the step by step construction of GST tax dynamics model.

7.1) Industry Product Stock

Figure 9 shows the relations among the industry product stock and relevant variables, and the interactions with the ICMS tax collection. The industry product stock is subjected to the interest rate/consumption/investments flow. The higher the interests rate of the economy, the lower the investments and the lower the production. Additionally, the higher the interests rate, the lower the consumption, which implies the lower the demand rate of production and consequently, the lower the production itself.

More supply explains the production of goods and services, which induces an increase in consumption (sales) and in state tax capacity.

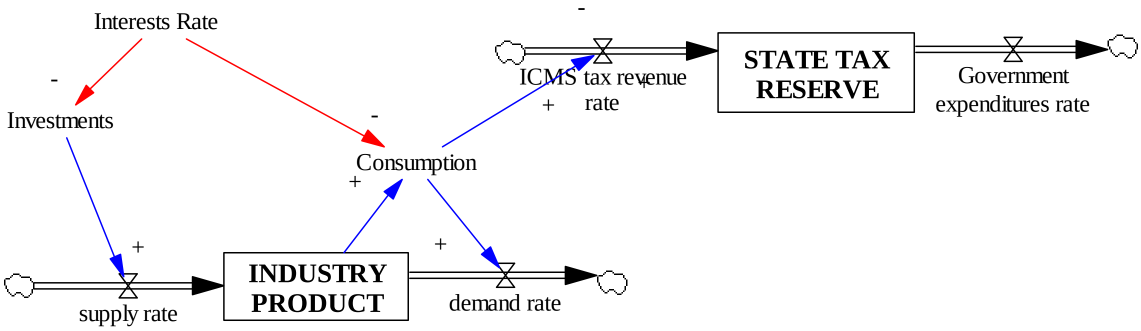

Figure 9 – State Tax Reserve / Industry Product relations.

7.2) Population Stock

Consumption is also based on size of population and on employment (number of jobs). Figure 10 includes the population stock and its positive relation with consumption and negative with employment. In other words, as the size of population increases, less job positions are available, which in turn causes debt. Both employment and debt affect consumption, the first directly and the last inversely.

Besides, consumption is reduced when inequality of household income increases, measured by the Gini index in previous econometric analyses, which also increases when employment decreases.

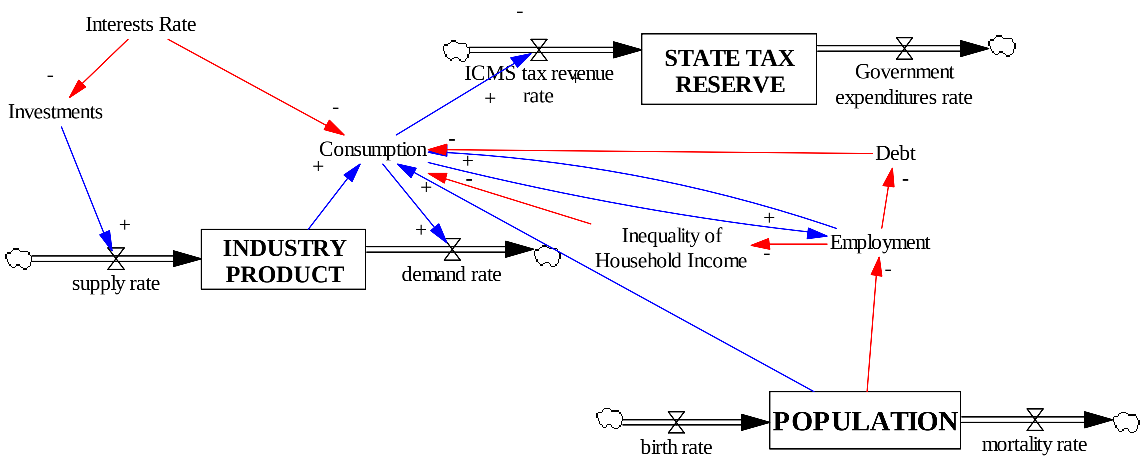

Figure 10 – Addition of population stock to the GST model.

7.3) OPENNESS OF THE ECONOMY – Goods and Services Export and Import

This entire picture is influenced by the openness of the economy, as shown in Figure 11 below. First, the number of jobs increases with the openness of the economy due to the increase of labor mobility, and consumption in general tends to increase, which in turn speeds up ICMS tax revenue collection.

Goods export increases the demand rate for products, which in turn leads to an increase in production. The increase in production also tends to increase goods export. Goods export doesn´t affect ICMS tax revenue rate directly because, as mentioned before, exports of goods and services were exempted from ICMS tax.

Goods import tends to reduce consumption of national products, which leads to a decrease in ICMS tax revenue rate. On the other hand, goods import increases ICMS tax revenue rate directly because ICMS tax is levied on imported goods.

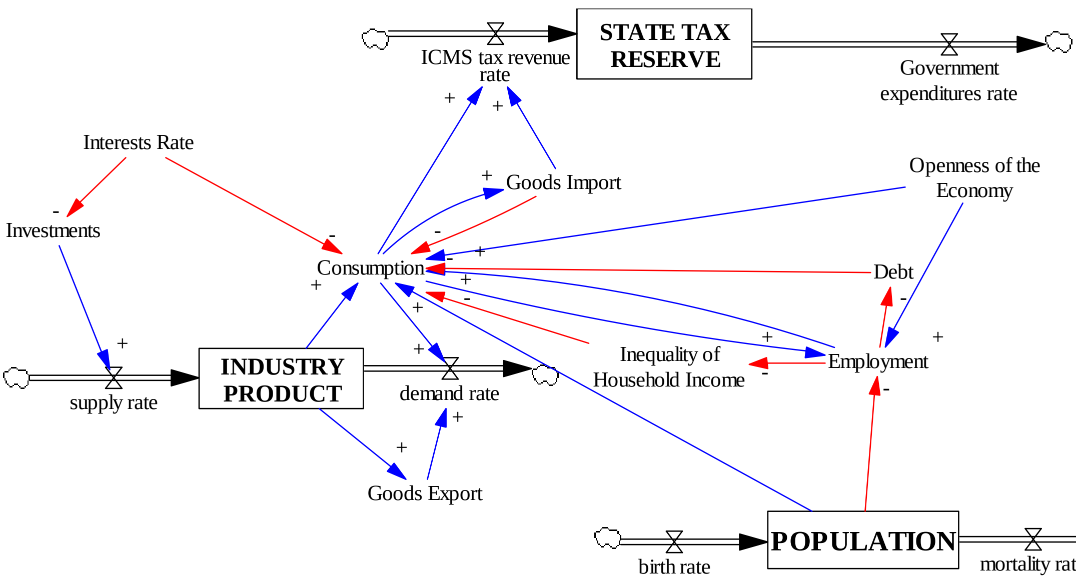

Figure 11 – GST dynamic model, including openness of the economy variables (foreign trade).

7) CONCLUSION

Measuring the structural potential tax capacity, based on the socioeconomic characteristics of state or country is not a trivial task. It is necessary to characterize the tax base by capturing effects of capacity of tax contribution (GDP and population), composition of the economy (sector products), foreign trade, degree of urbanization and others to construct models to estimate state or country tax capacity.

This paper studied a large set of variables that might explain tax capacity, including GDP, sector products and fuel sales variables used to measure economic performance. Exports and imports of goods were used to measure the degree of openness of the economy. As far as socioeconomic parameters, besides size of population widely used, number of formal jobs, default rate on credit operations which indicates debt, Gini index of income inequality and finally, a proxy of private sector were adopted.

The preliminary study of the dependent variable (ICMS) and the behavior of potential explanatory variables were very useful for building models. This study consisted of a graphical analysis of variables for the set of States, verifying trends and presence of outliers. In the case of ICMS variable, for example, exponential trend was observed, as well as presence of an outlier that would be São Paulo revenue, which is far higher than the other state revenues. Thus, measures were taken to correct possible distortions that could happen, such as using ICMS logarithm aimed the variable linearization, and employing a third of São Paulo ICMS revenue. It was also found exponential behavior of GDP, population, sector products and fuel sales, indicating the use of these variables logarithm as well. Regarding trade variables, it was found quadratic trend, indicating the use of these variables square root.

Additionally, analysis of correlation level and signs between ICMS and explanatory variables was important to select which variables had power to explain it as well as the expected signs. Thus, positive and over 0.8 correlations were found between ICMS and GDP, population, industry and service products, fuel sales, exports and imports. Negative and between 0.5 and 0.8 correlations were found between ICMS and Gini index, and positive between ICMS and formal jobs and agriculture product. Finally, low correlations below 0.2, negative and positive, were found between ICMS and default rate and between ICMS and private sector proxy, respectively.

On the other hand, high levels of correlation between independent variables possibly introduced colinearity issues in models. In this study, it was observed a high degree of correlation among the variables that were indicative of economic activity, leading the use of only one variable of this group in the estimation models.

Several models using the method of OLS in Gretl were tested. In general, it was obtained a good degree of fit in almost all models tested and they all showed significance of the set of variables using the F test. However, few models presented all variables significant at least 10%, in addition to be simultaneously successful in Reset test for good model specification, Breusch-Pagan test for heteroscedasticity and colinearity test.

Choosing the best model should be based on objective criteria, for example, containing all statistically significant variables, expected signs of coefficients and good degree of adjustment, besides meeting the requirement tests and the classic assumptions of the OLS method. It should be taken into account the principle of parsimony in all cases to choose the simplest model that still meets the requirements. According to that, the selected model was one that explains ICMS logarithm by industry product logarithm and population logarithm.

The potential tax capacity results were used to calculate the Tax Effort Index (TEI) of Brazilian States. The highest TEI obtained were 1.86, 1.48 and 1.39 for Distrito Federal, São Paulo and Mato Grosso do Sul, respectively. Exogenous situations to the economic base of these States discussed before raised their index. On the other hand, the lowest results of IEF of 0.61, 0.70 and 0.72 were observed in the States of Pará, Sergipe and Acre, respectively, because some major economic activities of these States, especially the first two, are not reached by ICMS legislation, already discussed.

The Tax Effort Index is a useful tool for analyzing fiscal performance, which allows comparisons between countries or states. It can even be considered for feasibility studies of tax burden raising or even as a guide to tax enforcement actions. However, TEI should not be used mechanically as an absolute truth. Its calculation is linked to econometric models estimation, which always requires additional analysis and verification of results.

Econometric models don't capture the feedback relations between factors. Because of that, a combination of econometric studies with system dynamic models seems to be a promising way to explain ICMS behavior and its interaction with socioeconomic variables. Therefore, a SD model was built step by step, which helped to have a comprehensive view of the GST dynamics, quite important for the Brazilian States in their current economic situation.

Further studies will include time dimension in the econometric model by using panel data. The obtained relations between GST and explanatory variables will be added in the SD model in order to obtain feedback responses and improve the understanding of the GST dynamics.

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