ANALYSE OF TAX COMPETITION IN BRAZIL USING THE SYSTEM DYNAMIC APPROACH

Abstract

The present study analyzes the systemic interaction of tax competition in Brazil, aiming to identify the elements that perpetual this practice and its effects on the economy. It should be noted that according to the proposed model, the results obtained with the tax competition is not even optimal condition for the less favored resource region (Northeast). Since, upon the incursion of specific investments in infrastructure (in the same amount of tax waivers), the behavior of GDP, infrastructure and revenue would be higher in this region. For this reason, it is evident that in the sub-national level (decentralized) the only alternative industrial policy for the less affluent is the granting of tax incentives. However, this type of policy is effective palliative and temporary and does not constitute, per se, a sustainable policy to fix the route of economic concentration. It remains for the central government to put private investment policies in place to income the attractiveness of these regions. Otherwise, these regions do not have incentives to reduce tax competition.

Key words: tax competition, macroeconomic, government investments

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1. Introduction

The industrialization, leveraged since 1930, developed a scheme of inter-regional division of labor, setting the framework for regional disparities (DULCI, 2002). The interconnection of regional markets, previously isolated, together with the adoption of policies to protect the domestic market and resulting economic dynamism of coffee contributed to the industrial concentration in the Southeast, especially in São Paulo. This industrial complex gained strength from the adoption of an exchange rate policy directed at restricting imports, and increased the centrality of the state economy at the expense of less developed regions.

Given the advanced process of uneven development, it became evident the need to adopt measures to mitigate the distortion in the wide portion of land placed outside the process of economic growth. In this sense, the federal government created the Superintendence of Northeast Development (SUDENE) and Amazon Development Superintendence (SUDAM). According Dulci (2002) these agencies consolidated line of action of the federal government with regard to the efforts of economic recovery in peripheral areas - in relation to the axis of the industrial south - through institutional mechanisms, particularly in the tax field.

For the states with an intermediate development position, the delay did not get in dimensions to justify the strategic action of the federal government adopted political and institutional resources to reduce their economic backwardness. Given the political importance of these states, their disputes for investment attraction resulted in tensions between federal entities. Therefore, it was necessary the active role of the federal government to balance competing interests and ensure national unity. In this sense public initiatives have been promoted for expansion and modernization of infrastructure and promotion of development (SILVA; OLIVEIRA, 2007).

The active participation of the federal government in correcting the distortion was legitimized by the need to uphold the federal pact in heterogeneous conditions of the Brazilian states. The presence of a strong and inductor state assumed centralizing character, both in tax collection, and the application of resources. From mid-1980 through the fiscal crisis and the decline of the military regime, there was a trend and democratic decentralization, which gave more power to the states and municipalities. The thrust towards decentralization of political and financial support was given by the 1988 constitution, which stipulated that each state has autonomy to legislate and fix the rates of taxes imposed by the state.

The decentralization promoted by the constitution of 1988 reduced the income of the Union, which, before the economic crisis and the need for fiscal adjustment, adhered to the logic of phased withdrawal of the "State" in the economy. This, coupled with the

progressive opening of the Brazilian economy, provided a favorable environment to the state contests. Given that economic liberalization attracted an increasing flow of foreign capital interested in investing in the country and that states had the freedom to fix their tributes, each federative entity has to compete with others in attracting private investment into their respective territories. The tools used in these disputes are the tax exemptions and tax expenditures, and given the name "tax war" (Arbix, 2000).

Wildasin (2011, p. 1313) states that the competition for mobile factors of production can be better understood when examined through a "Explicitly dynamic framework", that is, through an analytical framework to present the dynamic causal relationships occur where interactions. According to the author, this approach allows to detect the speed and magnitude of adjustment of economic variables in response to policy changes and to compare their results in different scenarios.

Therefore, this study seeks to understand the interaction of systemic emerging tax competition for new investments in Brazil, and to assess its economic impact. The analyze of this problem from the perspective of system dynamics possible to find counter-intuitive elements that encompass the intergovernmental competition, and to draw conclusions and point out possible ways that go beyond the prescriptive requirements in the literature that focuses these theme.

Besides this introduction this study contained three sections. The next section presents the theory fundaments of system dynamics, considered the archetypes, the simulation model of tax competition between two regions, as well as the handling of the model and data sources. Then we describe the simulation results and evaluation of scenarios and finally, the last section presents the conclusions and suggestions for further work.

2. Methodology

This study covers the Southeast and Northeast regions which account together about 70% of Brazilian GDP. The choice of such regions is due to the fact that properly represents the contrasts in terms of capital allocation and infrastructure resulting from the process of uneven development. Arbix (2000) and Dulci (2002) also add that these two regions are composed of some of the states that stood out as the great promoters of the "war" on several fronts.

In order to meet the objectives of this work a systemic model of tax competition for new investments between two regions using the system dynamic approach are developed. To identify causal relationships and feedback loops two systemic archetypes: "Success to the successful" and "escalation" are combined. The methodology of system dynamics was initially developed by Forrester (1961), in order to track the effects of policies on the state of the system. The method of system dynamic allows the calibration of the behavioral parameters that are adherent to the reality of the competitive dynamics between the analyzed regions. Thus, after calibration, is possible to perform simulations and to analyze scenarios.

The process of tax competition is systemic in nature, since the adoption of one implies downside the other. This individual behavior brings out an unintended path that restricts the ability of regional governments to ensure the provision of public goods and services, as well as the incursion of systematic regional development policies.

Present in several areas of knowledge, the phenomenon of emergence is understood as a process of self-organization that results from the interaction between the actors. The emergency occurs so often unintentional and the result of individual actions which, although considered rational in the strict sense, can not anticipate the collective result of these actions (Jervis, 1997). Bueno (2009) points out that the emergence is a property of complex systems that exhibit dynamic complexity.

The dynamic complexity derives largely from the idea that the interaction between systemic agents in the environment occurs in the form of feedback loops, which may take the form of reinforcement (positive) or balance (negative). Sterman (2000) puts this environment that apparently isolated actions of individuals can trigger other reactions, changing, in the subsequent period, the conditions under which the decisions were taken at first. Thus, individuals may also change their strategies in response to the strategies of other agents, as well as changes in physical and institutional environment. The result is that in dynamically complex systems, decisions produce, in general, results not intended by their makers, where the effects are away from their causes through delays (lags).

As a result, the system dynamics is the most appropriate approach to analyze the dynamic interaction in complex systems, it consists of a set of techniques designed to evaluate systems controlled by feedback loops. This approach enables the construction of co-evolutionary models for institutional dynamics, and to identify the most relevant causal chains present in the model.

2.1 Archetypes

Based upon the studies of interactions, the system dynamics group at the Massachusetts Institute of Technology (MIT) identified eight common systemic structures, which apply to a wider range of social interaction situations. These structures are called systemic archetypes, being developed from different combinations of loops and strengthening the balance sheet (Kim, 2000). The following are two of these archetypes: the “escalation” and “success to success”.

The archetype "escalation" expresses the race between two players (regions) that wants to achieve a privileged position in relation to your opponent. Thus, if the region puts the ongoing decisions that improve their relative position (policies on tax incentives), the region B considers this practice as a threat to their security. In response to this threat, B also decides to grant tax incentives, rebuilding their relative position (in terms of the attractiveness of investments). However, A also believes the initiative to B as a threat and, therefore, responds with expansion of the policy initiated. Although the individual action produces loops balance - that is, considering only their isolated action,

the increase in tax incentives improves its relative position and therefore discourages the continuation of this expansion in a subsequent period - each agent reacts to the initiative of another with intensifying process already underway, resulting in a process of strengthening the fiscal war. The tax competition literature classifies this phenomenon as "race-to-the-bottom" (ZODROW; MIESZKWSKI, 1986). Figure 1 represents the causal diagram of the escalation.

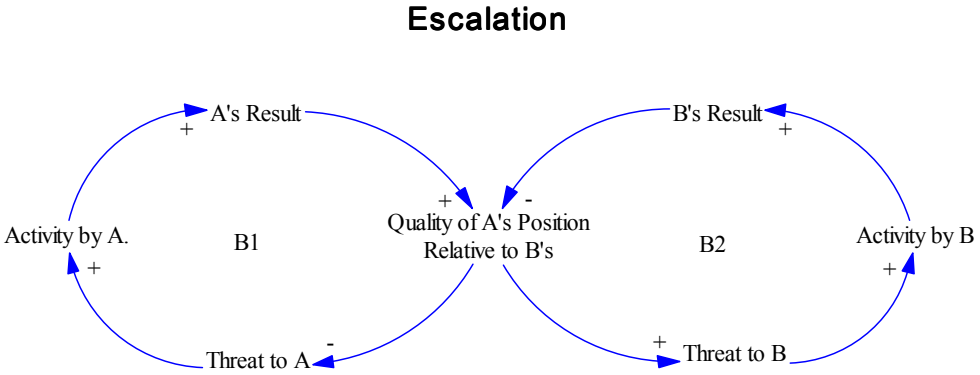


Figure 1 - Archetype "Escalation".
Source: Kim (2000)

The second archetype of success for the goods expressed a successful scenario of hypersensitivity to initial conditions. In this situation the region that gets a head start even if temporary, such as better infrastructure and logistics, as a result of this relative gain, follows a path of gradual concentration of investments in its territory. If not offset by other policies or loops, the loop reinforcement tends to produce increased industrial concentration in the first region, while the other becomes increasingly poor. Figure 2 illustrates the said archetype.

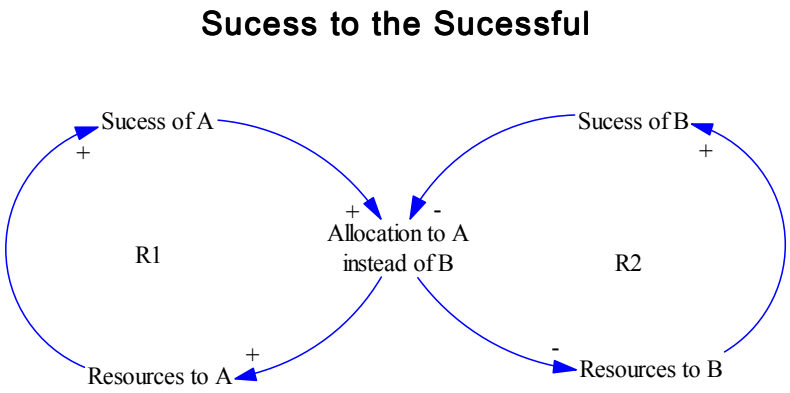


Figure 2 - Archetype "Success to the Successful".
Source: Kim (2000)

2.2 Simulation model

The system model employed in this study was adapted from the models proposed by Wilson and Wildasin (2004), Keen and Marchand (1997), Zodrow and Mieszkwski (1986). As a result, the proposed model was built from six basic postulates, which are:

1. There are only two types of jurisdiction in the country:
   a) Rich region - with better allocation of capital, infrastructure and logistics. Therefore more attractive to private investment, and
   b) Poor region - with low allocation of capital, infrastructure and logistics. Therefore less attractive to private investment;
2. Individuals are homogeneous and no mobility between regions (KEEN; MARCHAND, 1997);
3. Capital is mobile only in the form of new investments, that is, once immobilized the inversion is not possible to remove it to another jurisdiction;
4. Each sub-national government seeks to maximize the welfare of its citizens and has autonomy in the conduct of fiscal policy, but should maintain the fiscal balance (KEEN; MARCHAND, 1997, MINTZ, Tulkens, 1996, ZODROW; MIESZKWSKI, 1986);
5. There is no spatial spillover or externality tax, i.e. tax policy and public goods in each jurisdiction does not affect the results of others (ZODROW; MIESZKWSKI, 1986);
6. Public expenditures are divided into two categories:
   a) Social programs expenses including social security, income transfers, health, education and leisure;
   b) Public investment in infrastructure, capital goods, flooring, lighting and urban design.

The influence diagram shown in Figure 3 presents the causal interaction between the two regions (A and B) competing for attracting private investment into their territory. The arrows indicate the causal relationships between variables in the model, and the positive sign in the arrowhead indicates a direct relationship, while the negative sign an inverse relationship. The arrows marked by two parallel bars have gaps (delays) between the effects of change in a variable on the other variable.

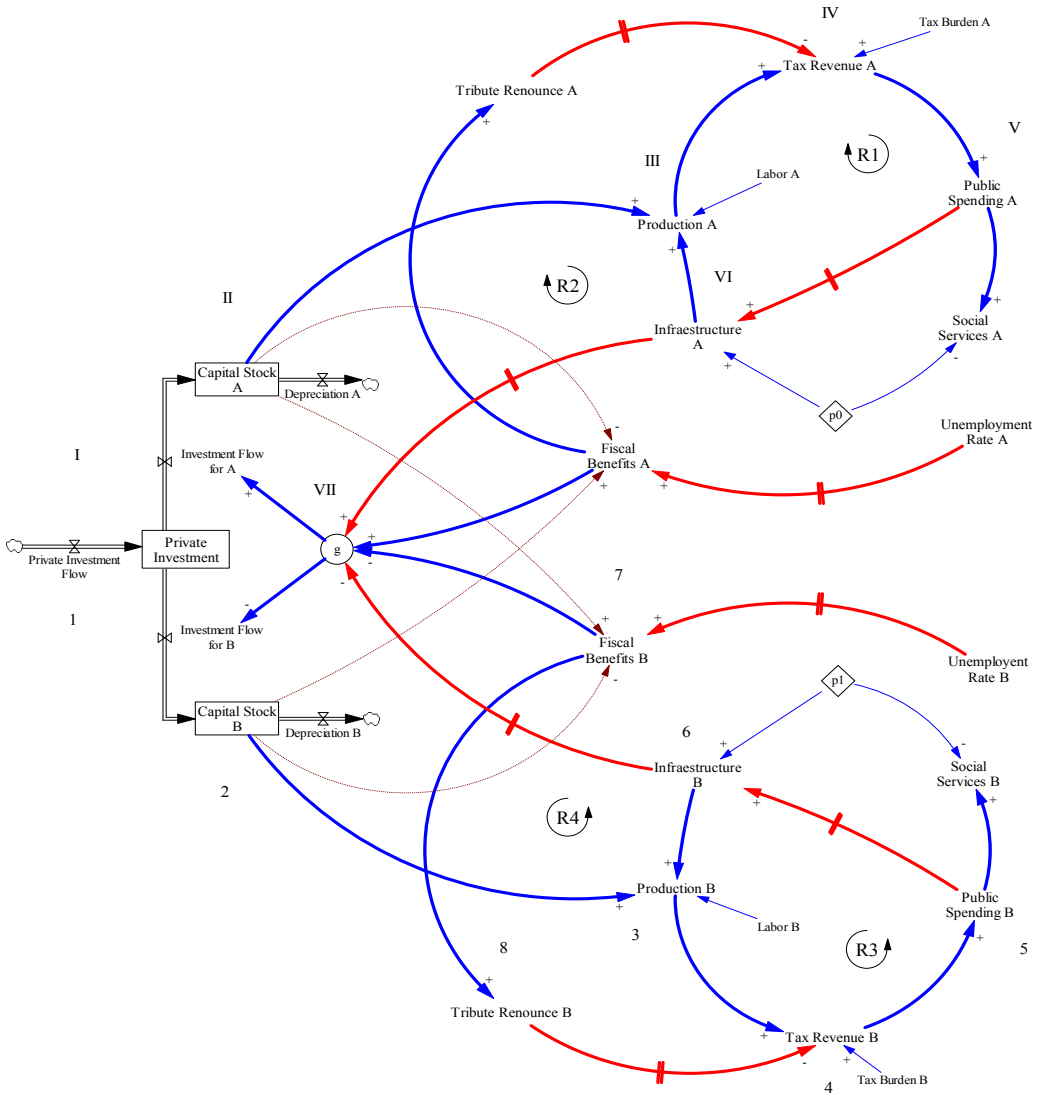


Figure 3 - Diagram of the systemic interaction between two regions.
Source: Authors

The logic contained in the diagram is a combination of archetypes analyzed previously applied to the problem of tax war. Suppose there are only two regions and that the total investment flow is determined exogenously, where (g_t) is the proportion of investment for the region A and $(1 - g_t)$ is the portion allocated to the B region. Assuming that, due to better allocation of infrastructure and logistics, the region receives a greater proportion of private investment to the region B (steps I and II), this leads to higher production of A (step III) (WILSON, Wildasin, 2004 .) The increased production of A increases tax revenues in the region, increasing public spending on infrastructure and social services (steps IV and V). The level of the infrastructure increases after a delay (step VI) and consequently the production increase too, which results in the first cycle of reinforcement (R1). With a better infrastructure the attractiveness of capital also increases, resulting in a higher proportion of investment for A (step VII).

The model proposed here is a zero sum so that increasing the proportion of investment for the same reduction means in the portion intended to B, region B in engaging a reverse path to the analogous region A. Therefore, the reduction in investment in B reduces the capital stock, which decreases the production and public spending on infrastructure (steps 1-6). After some time loops are triggered reinforcements (R3 and R4), since the lower level of infrastructure restricts production and reduce the attractiveness of investments. Thus, the region gets a head start (region A) remains on a path of continuous distance to the less privileged state (region B), as already provided the archetype for the successful succeed.

However, realizing his persistent disadvantage compared to their neighbors, the policymaker decides to implement policies of tax incentives in the region B (step 7), in order to attract more private investment into its territory and reduce unemployment. Tax incentives, as the name suggests, stimulate investment in the territory for which it is directed, increasing the proportion of investment in B, as well as the production level after some time. The increased production tends to increase government revenue, but its influence is balanced (step 8) for tax waivers. Assuming that the vector is superior to the resignations of revenue resulting from increased production, we conclude that the collection and spending of B decrease, leading, after a delay, poor infrastructure of the state and the consequent reduction in the attractiveness of private investment (Steps 4, 5, 6 and VII).

It should be added that, after the policymaker realize the strategy for the region B, this does not hesitate to "fight back" in order that fails to capture the systemic effect of the initiative to B - mentioned in the previous paragraph. So that both erupt into a real "escalation" in search of a greater amount of private investment, as the archetype admitted.

So here was shown a diagram of systemic tax competition, with the specification of causal relationships in the form of stocks and flows. It now remains to introduce the system of differential equations describing the system dynamics.

The production of each region is determined by a combination of factors capital (K), manpower (L) and infrastructure (I) (KEEN; MARCHAND, 1997). The functional form of production takes the specification of the cobb-douglas, with variable returns (Wildasin, 2011, Wilson 1995). The equation which defines the production function is shown below:

$$Y_t = f(I_t, K_t, L_t) = {L_t}^w {K_t}^q {I_t}^z) \quad (1)$$

$$I_t = \int (\beta_0 {I_P}_{t-1} - {D_I}_t)\, \partial t \quad (2)$$

$$K_t = \int (F_{K_t} - D_{K_t})\, \partial t \quad (3)$$

where I_t = infrastructure; K_t = capital stock; L_t = manpower in each period.

The level of public infrastructure (I_t) is determined by the integral of the difference between public investment lag $(I_{P_{t-1}})$ multiplied by a parameter (β_0) and the depreciation of the infrastructure (D_{I_t}) - see equation (2). Since the capital stock (K_t) is given by the integral of the difference between the flow of private investment (F_{K_t}) and depreciation of capital (D_{K_t}), according to equation (3). The variable manpower (L_t) in turn, is determined exogenously to the model, representing the population of the region (ZODROW; MIESZKOWSKI, 1986).

The only source of government revenue is its own tax collection (A_{T_t}), which, as shown in (4), results from a combination of regional output (Y_t) times the tax rate (C_T) of the region minus the tax waivers (R_{T_t}). The amount of tax waiver (R_{T_t}) for the current period is equal to the tax incentives lagged $(I_{F_{t-1}})$, which were granted in the previous period, as in (5).

$$A_{T_t} = (1 - R_{T_t})C_T Y_t \quad (4)$$

$$R_{T_t} = I_{F_{t-1}} \quad (5)$$

Given that public spending must respect the limits of its budget revenues and public expenditures are divided into three categories:

$$A_{T_t} \geq G_{P_t} = G_{S_t} + I_{P_t} \quad (6)$$

Where G_{P_t} = public spending; G_{S_t} = social spending and social services, and I_{P_t} = public investment.

Additionally, it is assumed that the proportion of spending allocated to public investment (I_{P_t}), and social spending (G_{S_t}) can be changed depending on the interest of the ruler. However, due to the limited room for maneuver, a proportionate increase in investment spending implies a reduction in social spending and vice versa. The proportional distribution is expressed by following equations:

$$I_P = p_0 G_P \quad (8)$$

$$S_S = G_S = (1 - p_0)G_P, \text{ in wich } 0 \leq p_0 \leq 1 \quad (9)$$

Where p_0 = proportion of spending on public investment, and $(1 - p_0)$ = the proportion of social spending.

For the parameter (p_0) is assigned the value of 0.22. For Rock and Giuberti (2007), capital spending represents on average 22% of state budget expenditures. Thus, other government spending, in this model, goes to social spending.

The unemployment rate (μ_t) obtained from equation (10) follows the principle proposed by Okun's law, where the unemployment rate is the sum of the natural unemployment rate (μ_N) and the output gap $(Y_N - Y_t)$ multiplied by the coefficient adjusting $(\propto_0)$. When the product is far from the effective potential, the unemployment

rate is far from the natural rate. If the actual output is above potential ($Y_t > Y_N$), the unemployment rate is lower than the natural ($\mu_t < \mu_N$), the opposite being true (MANKIW, 2004). To estimate the values of the difference ($Y_N - Y_t$) of the product will be used a statistical procedure called the Hodrick-Prescott (HP), a smoothing method widely used in literature to extract the cyclical component of the series (ASSISI, DIAS, 2004).

$$\mu_t = \propto_0 (Y_N - Y_t) + \mu_N, \text{ onde } \propto_0 > 0 \qquad (10)$$

Where μ_N = natural rate of unemployment; Y_N = potential output.

The role of tax incentives granted by the regional governments to attract new investment is described by combining two other functions: IF THEN ELSE and lookup. The first is to provide a logical proposition as described below:

$$\begin{aligned} &IF\ THEN\ ELSE\ [\quad \mu_t \leq \mu_P \\ &\text{(true)} \quad \Longrightarrow \quad [\ I_{F_t} = 0\ ] \\ &\text{(false)} \quad \Longrightarrow \quad [\ I_{F_t} = flookup_1(\tfrac{K_B}{K_A})\ ]\ ] \end{aligned} \qquad (11)$$

The function attempts to test if the unemployment rate (μ_t) is less than or equal to the level tolerated by the policymaker (μ_P). If the proposition is true, the amount of tax incentives will be null ($I_F = 0$), i.e. the policymaker will not compromise future income to attract capital and create new jobs. On the other hand, if the unemployment rate is not at acceptable levels, the policymaker puts the current tax incentives to attract private investment.

The amount of tax incentives, i.e. the percentage of future revenues that the government resigns, is determined by the equation $I_F = flookup_1(\frac{K_B}{K_A})$, whose relationship is represented by the lookup function described in Figure 4. It is assumed that, the higher the relative endowment of the neighboring region capital ($\frac{K_B}{K_A}$), the greater the incentives granted by the policymaker to attract private investment into its territory. Thus, as it reduces the attractiveness of a region in relation to investment, this region can extend tax incentives grants.

However, each region can not commit more than 6% of its revenue in future incentives.

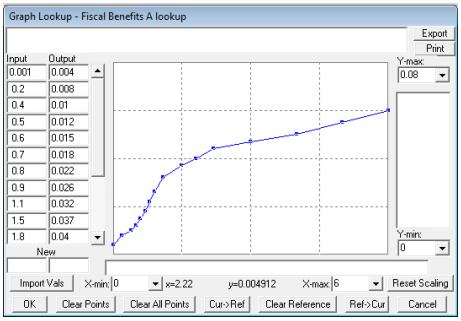


Figure 4 - Graph of the fuction Fiscal Benefits A lookup.
Source own elaboration.
Note: imput = values of the explanatory variable, output = value that the function can assume.

Finally, it remains to explain how the flow of capital is directed to each jurisdiction. The value of the ratio of private directed to the region (g) is determined by equation (12).

$$g_t = \gamma\left(\frac{I_{A_t}}{I_{A_t}+I_{B_t}}\right) + (1-\gamma)\left(\left(\frac{I_{F_{A_t}}}{I_{F_{A_t}}+I_{F_{B_t}}}\right) - 0{,}5\right) \quad (12)$$

To better understand this relationship, first consider the situation in which regions do not grant tax incentives ($g_t = \gamma\left(\frac{I_{A_t}}{I_{A_t}+I_{B_t}}\right)$). Thus g will be influenced only by the relative endowment of infrastructure in each region multiplied by a conversion factor (γ). For example, assuming that $\gamma = 1$ if both regions present an equivalent level of infrastructure, the proportion of investment in each region will be the same ($g_t = 0{,}5$) – each region receives 50% of total investments. However, as the region gains displaying infrastructure superior to B ($\frac{I_{A_t}}{I_{A_t}+I_{B_t}} > 0{,}5$), g_t grows and increases the flow of investment directed to A. The opposite occurs in a similar manner. According to Wilson and Wildasin (2004) firms are benefiting from public spending in infrastructure and because of this, their investments are concentrated in regions with better allocation of this factor.

When tax incentives are granted, this is a sign that at least one government is not satisfied with the way in which private investment are shared - the value that g_t takes. As a result, the function is an additional component, namely, $\left(\left(\frac{I_{F_{A_t}}}{I_{F_{A_t}}+I_{F_{B_t}}}\right) - 0{,}5\right)$. The function indicates the net effect of this compensation policy incentives resulting from low investment attractiveness policymaker that some judges may exist in its territory. This effect is given by the difference in the proportion of incentives by A in relation to all involved in the two regions. If both regions give the same amount of incentives, this has no effect. However, if the region B dispend a greater volume of incentive $\left(\left(\frac{I_{F_{A_t}}}{I_{F_{A_t}}+I_{F_{B_t}}}\right) < 0{,}5\right)$, the amount of investment for A, ceteris paribus, will decrease, and otherwise a similar manner.

For the model does not incur explosive trajectories and values incongruent (a mathematical indeterminacy) was added to the equation (equation 12) the functions IF THEN ELSE. So if there are tax incentives grants $(1-\gamma)\left(\left(\frac{I_{F_{A_t}}}{I_{F_{A_t}}+I_{F_{B_t}}}\right) - 0{,}5\right) = 0$. Thus, equation 12 can be rewritten as:

$$\textit{IF THEN ELSE}\ [\quad I_{F_{A_t}} + I_{F_{B_t}} = 0$$
$$\text{(Verdadeiro)} \Rightarrow\ [\ g_t = \gamma\left(\frac{I_{A_t}}{I_{A_t}+I_{B_t}}\right)\ ] \quad (13)$$
$$\text{(Falso)} \Rightarrow\ [\ g_t = \gamma\left(\frac{I_{A_t}}{I_{A_t}+I_{B_t}}\right) + (1-\gamma)\left(\left(\frac{I_{F_{A_t}}}{I_{F_{A_t}}+I_{F_{B_t}}}\right) - 0{,}5\right)]\ \ ]$$

2.3 Handling the model

The calibration procedure allows to adjust the parameters so that the endogenous variables of the model adhering to real economic series. The adjustment of errors simulated in relation to the actual values of each variable was obtained using the calibration tool of the software Vensim, version 5.7.

The simulation model of tax competition in Brazil was calibrated considering four sets of real data, which are: the GDP of the Southeast, Northeast regions and tax revenue in the Southeast and Northeast. It should be noted that different weights were adopted for each series in order that the differences in magnitude does not come to favor certain series at the expense of others. After testing different combinations of weighing, we opted for the combination shown in Table 2, for being who approached simultaneously the series for the Southeast and Northeast.

Table 2 – Series' weighing of the calibrated simulation model

Series	Weight's parameter	Value
Southeast GDP	$w1$	0,20
Northeast GDP	$w2$	0,40
Southeast Tax Revenue	$w3$	0,15
Northeast Tax Revenue	$w4$	0,25

Source: Developed by the authors.

2.4 Source and data processing

The series used in the modeling of tax competition in Brazil in the Gross Domestic Product (GDP) in Southeast and Northeast and the projection of the resident population in each region as a proxy for hand labor were extracted from the database of the Institute for Research in Applied Economics (IPEADATA). The series of state tax revenue from the two regions (deflated by the implicit deflator of GDP) were collected from the National Treasury Secretariat (STN). Additionally, it was used as a proxy for private investment the sum of energy consumption (in Gigawatts) in the industrial sector of both regions, obtained from the site of the Central Bank of Brazil. According to Casali, Silva Carvalho (2010) power consumption is highly correlated with private investment, since the more intense the investment in machinery and equipment, the greater the energy consumption by industries.

All data correspond to an annual series; the period begins in 1985 and extends until 2005. To standardize the units of measurement used in the simulation all series were standardized in terms of the proportion of each variable in relation to the total GDP of the regions in 2008. Exceptionally series relating to manpower were normalized in terms of the proportion of the total population in each territory also distributed in 2008. Thus, the values assumed by each variable have been set as shown in Table 3.

Table 3 – Normalized values of each variable in 2008

Series	Normalized value
Southeast GDP	81,04
Northeast GDP	18,96
Southeast Tax Revenue	6,84
Northeast Tax Revenue	1,71
Southeast Labor	60,17
Northeast Labor	39,83
Private Investment of the two regions	15

Source: Developed by the authors.

3. Results of the simulation

3.3.1 Adjustment of the model

The structural behavior of the model of tax competition has been defined through a system of differential equations and causal relationships presented in the previous section.

The calibrated parameter settings and their values are shown in Table 3. The parameters q,w and z correspond respectively to the coefficients capital return, manpower and infrastructure of the production function. As the production function is specified the type cobb-douglas, the coefficients are the production elasticity for each factor.

The value assumed by the conversion coefficient of public investment in infrastructure (β) indicates that the investments are similar in both regions.

Table 4 – Calibrated parameters of the fiscal model

Parameter	Value	Description
q_0	0,5298	Capital return coefficient on production in Southeast
q_1	0,4910	Capital return coefficient on production in Northeast
w_0	0,2144	Labor return coefficient on production in Southeast
w_1	0,1750	Labor return coefficient on production in Northeast
z_0	0,4600	Infraestructure return coefficient on production in Southeast
z_1	0,4600	Infraestructure return coefficient on production in Northeast
β_0	0,9350	Transformation coefficient of public investment in infrastructure in Southeast
β_1	0,9399	Transformation coefficient of public investment in infrastructure in Northeast
μ_{N_0}	0,1005	Natural unemployment rate in Southeast
μ_{N_1}	0,0943	Natural unemployment rate in Northeast
α_0	0,0034	Business cycles effects coefficient on Southeast unemployment
α_1	0,0076	Business cycles effects coefficient on Northeast unemployment
TB	0,0600	State jurisdiction tax burden before 1988 constitution
TBA	0,0260	Tax burden change in Southeast after 1988 constitution

TBB	0.0290	tax burden change in Northeast after 1988 constitution
Gastos Pub. Delay A	0,8972	Initial value of public spending in Southeast
Gastos Pub. Dealy B	0,0100	Initial value of public spending in Northeast
Depreciação Infraestrutura A	0,1000	Infraestructure depreciation rate in Southeast
Depreciação Infraestrutura B	0,1000	Infraestructure depreciation rate in Northeast
Depreciação Capital A	0,0743	Capital depreciation rate in Southeast
Depreciação Capital B	0,0656	Capital depreciation rate in Northeast
Capital Delay A	60,0000	Initial value of capital stock in Southeast
Capital Delay B	21,8704	Initial value of capital stock in Northeast
Infraestrtura Delay A	6,5349	Initial value of infraestructure level in Southeast
Infraestrutura Delay B	1,7783	Initial value of infraestructure level in Northeast
γ	0,8947	Adjustment coefficient of private investment in relation to regional distribution of capital

Source: Search results.

Note: * The index 0 and 1 correspond to the Southeast and Northeast, respectively. A ** = Northeast. B = *** Southeast. CT = **** tax burden.

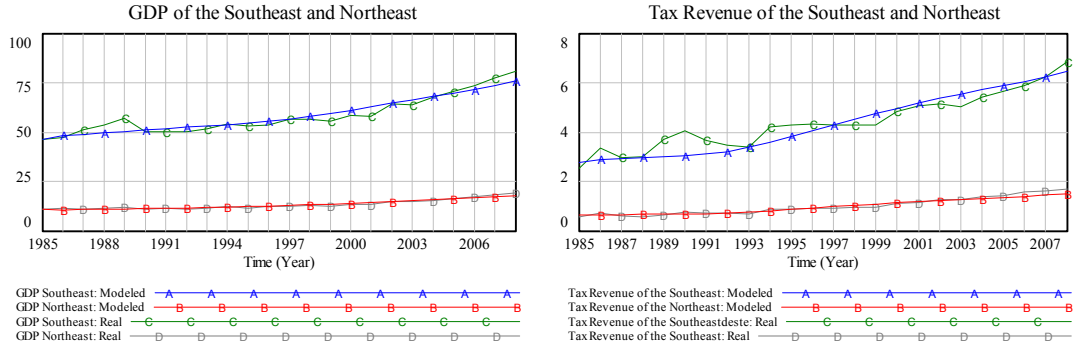
We highlight the natural unemployment rate (μ_N) set the template for each region. The calibrated values indicate that the Southeast region has a natural rate of unemployment higher than the rate in the Northeast, although the values are not so distinct. This difference in values is supported by the data presented by Pochmann (1998) concerning the unemployment rate by geographic regions between 1989 and 1996, where the Southeast region had unemployment higher than the Northeast. The parameter which represents the effect of economic cycles on the level of unemployment was also lower in the Southeast region, indicating that this is ,ceteris paribus, less susceptible to fluctuations in employment that the Northeast.

Regarding the tax burden was possible to detect a difference between the periods before and after the enactment of the Federal Constitution (FC) in 1988, when states acquire greater autonomy in the administration of taxes in their jurisdiction. The tax burden (CT) model is adjusted by 6% until 1988, during which there is no distinction between rates of states (Nascimento, 2008). Since 1989 both regions begin a gradual increase in their tax burdens, but in distinct ways. The Southeast region stabilizes at a value of the tax burden of 8.6% (CT + CTA), while the Northeast is now 8.9% (CT + CTB). Although not distance themselves from this, it is noticed that there is a difference between the prices charged by each region. This indicates that the states make use of regions some autonomy in setting their tax jurisdiction. The fact that both regions increase their level of tax burden, each in its own way, reflects the decentralized aspect of the present Federal Constitution of 1988, which increased revenue sources in detriment of States and the Union (VIOL, 1999).

The remaining parameters fitted represent the initial conditions of the model relative to the stock of capital, level of public spending on infrastructure and investment in each region, where the Southeast had higher values as the Northeast region. The depreciation rates of capital and infrastructure in each region represent the only means of escape (exit mechanism) resource level of these variables. As a result, it is possible that the values of the depreciation rates are incorporated in other factors that affect the output of those resources (such as capital mobility between regions and countries). Finally, the parameter (γ) measures the effect of different spatial distribution of infrastructure on private investment decision while ($1-\gamma$) correspond the proportion to the effect of regional tax incentives on private investment decisions. Thus, we conclude that, according to the calibrated model, the influence proportion of infrastructure and tax incentives in the private investment decisions in each region are respectively 89.5% and 10.5%.

Additionally, the parameter (μ_P), which represents the level of unemployment tolerated by the policymaker, was defined based on an estimate of the NAIRU for Brazil developed by Silva (2008). According to him the true value of the Brazilian NAIRU is in the range between 7.4% and 8.5%. For this reason, in this study was found a range mean of $\mu_P = 0{,}08$.

Figures 5 and 6 shows the behavior of GDP and tax revenues series per region, enabling the adhesion of the calibrated model to real series. The calibration have been applied to four sets of real and potential fluctuations what allow the model capture better the behavior of certain series, as seems to occur with GDP in the Northeast. Despite any disturbances, the model has an acceptable visually degree of adhesion, so that the calibrated model can be considered structurally representative.



a) b)

Figure 5 – GDP's and tax revenues real and modeled in the Southeast and Northeast, 1985-2008.
Source: Search results.

3.3.3 Analysis of the variables

The analysis period (1985-2005) is marked by deep political and economic transformations in the national context. During the second half of the 1980s Brazil experienced a process of democratization accompanied by failed attempts to stabilize the price level, which came to be controlled only in mid-1994 with the Real Plan (GIAMBIAG et al., 2005). The economic and political instability, together with the growing pressure for fiscal adjustment and deficit reduction, not created a favorable

environment for investment in infrastructure. As shown in Figure 8 modeled levels of infrastructure in the regions remain on a downward trend until 1995. Since 1996 the regions expand the stock of infrastructure, with stronger growth in the Southeast. The southeast had an average growth of 1.69% while the Northeast was 0.96% annually.

The Northeast region has less infrastructure that the Southeast region, so this region has more attractiveness for new investments. Thus, in order to overcome this structural disadvantage, the Northeast is to grant tax incentives to attract such investment. As shown in Figure 9, the incentives are to be granted from 1989. Although the structural disadvantage is attributed solely to the Northeast, both regions are to be granted tax incentives. The explication are that the Southeast do not want to lose potential investment installed in your jurisdiction. As a result, the Northeast region need an additional effort (in terms of tax waiver) to become more attractive.

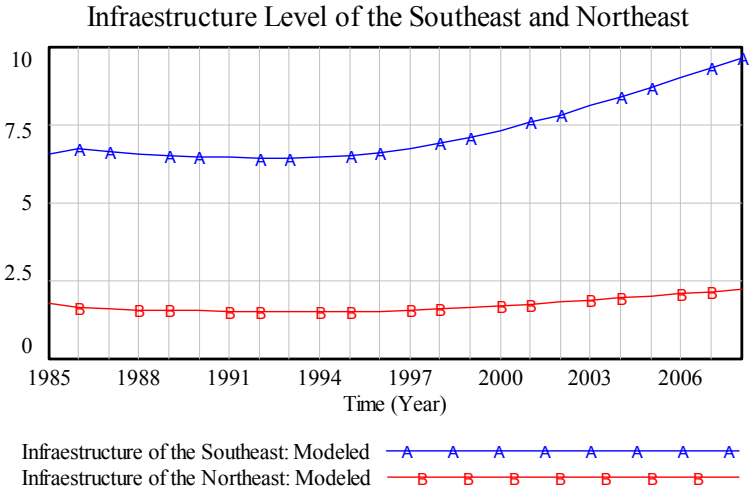


Figure 8 – Modeled level of Infraestructure in the Southeast and Northeast, 1985-2008.
Source: Developed by the authors.

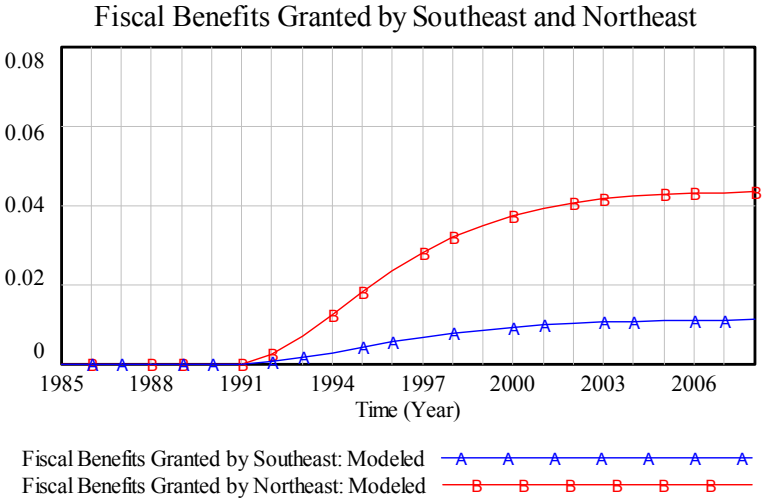


Figure 9 – Fiscal benefits granted by the Southeast and Northeast, 1985-2008.
Source: Search results.

Note, however, that the beginning of the tax incentive awards coincides with the expansion of the tax burden of the two regions - from 1989. That is, to circumvent the COMMITMENT revenue from tax waivers, the government increased tax rates imposed on society. It should be noted that tax competition encourage business groups awarded tax incentives and burdens the local productive sectors already installed. This evil character is more pronounced in the Northeast, since the increased tax burden and the amount of incentives is higher.

Because of the incentives, the Northeast region extends (from 1992) the volume of investments in its territory, as follows in Figure 10. It is also reduced, even so significant bit, the distance of the volume of interest of each region, as shown in Figure 11. Thus, it is possible to infer that tax competition has helped to reduce disparities in the spatial distribution of private investment, but its effects cannot systematically affect the distribution, since the growth of the stock of infrastructure was impaired by tax waivers and, consequently, reduced the attraction of private capital.

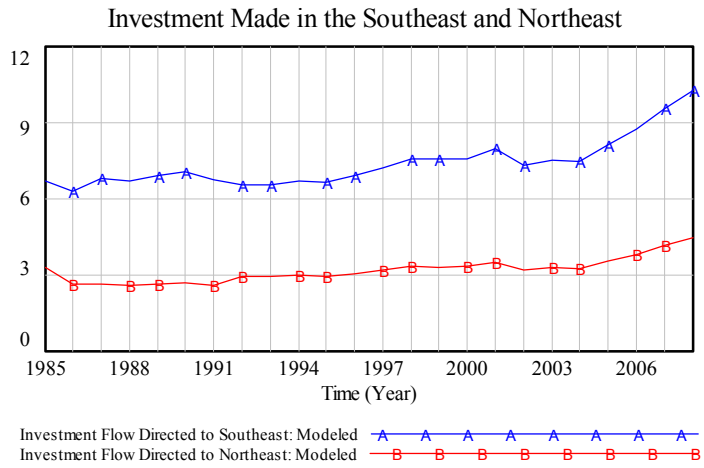


Figure 10 – Modeled investment flow for the Southeast and Northeast, 1985-2008.
Source: Search results.

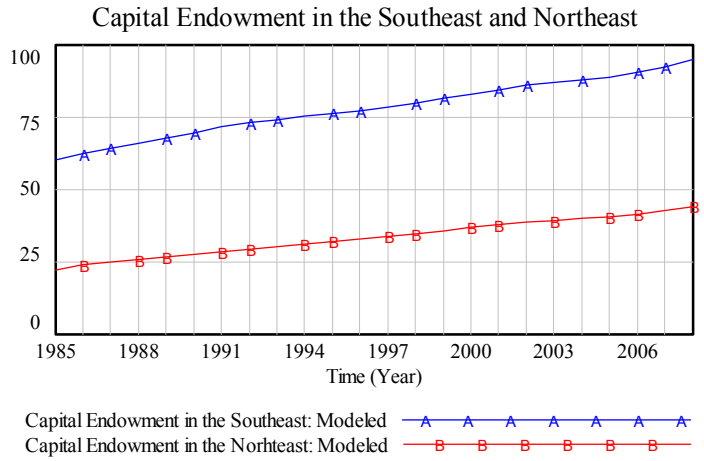


Figure 11 – Modeled capital stock in the Southeast and Northeast, 1985-2008.
Source: Search results.

Despite the amount of investment attracted to the Northeast, the trend of tax revenues remain as seen in Figure 12. The trajectory of unemployment patterned for the regions are shown in Figure 13. It's possible to check that the Southeast region as well as presenting a higher level of unemployment in almost all periods, also shows a higher rate of oscillation. This is because the region has major disturbances of GDP around its potential value, i.e. the presence of the cyclical component. On the other hand, the GDP of Northeast has more moderate behavior, allowing minor fluctuations in unemployment around its natural value.

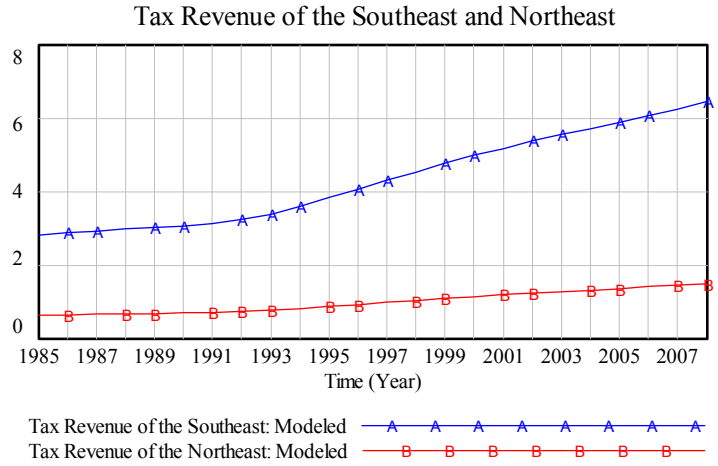


Figure 12 – Modeled tax revenues of the Southeast and Northeast, 1985-2008.
Source: Search results.

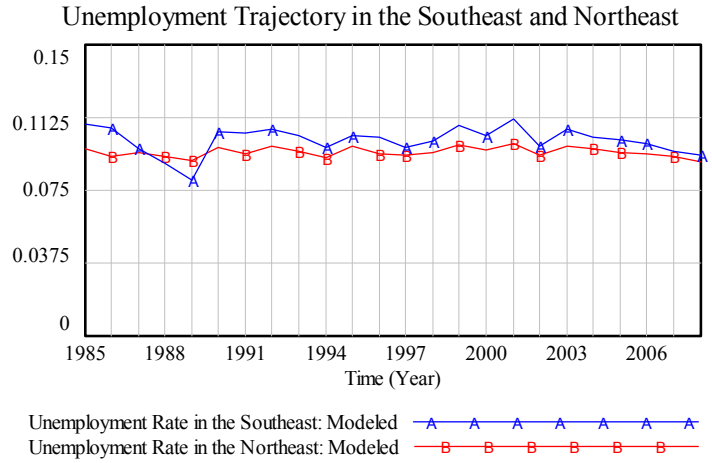


Figure 13 – Evolution of the modeled unemployment rate in the Southeast and Northeast, 1985-2008.
Source: Search results.

3.3.4 Scenarios analysis

The purpose of this section is to evaluate the behavior of the main series modeled upon the occurrence of certain transformations or changes of initial conditions,

which are classified as scenarios. The scenarios simulated in the model of tax competition between Southeast and Northeast regions are described in Table 3. Scenario 1 shows the system behavior in the absence of tax incentives. The second scenario is a standardization of state competence rates, i.e. to demonstrate the model behavior in absence distinctions between aliquots practiced by the regions. This standardization would be similar to the tax reform proposal contained in the constitutional amendment No. 42/2003 discussed by Paes and Smith (2004). According to this proposal, there would be the unification of the laws of GST and replacing it with a value added tax in order to extinguish the cascading effect of taxes and curb tax competition.

Box 3 – Simulated scenarios in the fiscal competition model

Scenario	Scenarios description
Scenario 1	Prohibition of the granting tax benefits.
Scenario 2	Standardization of the tax burdens.
Scenario 3	Standardization of the tax burdens combined with the end of tax benefits.
Scenario 4	Redirection of the tax benefits for public investment.
Scenario 5	Redirection of the tax benefits for public investment combined with the standardization of the tax burdens.

Source: Elaborated by the authors.

However, the mere standardization of tax rates does not address all the concerns contained in the proposed tax reform. However, this standardization represents the taxable percentage in the aggregate, not deducting the effect of waivers - granted for specific sectors. It is therefore necessary to keep some room for some special treatment - incentives to a portion of new investors. Accordingly, Scenario 3 is trying to meet these goals by combining the standardization of tax rates with the ban on incentives.

The last two scenarios attempt to evaluate the hypothesis that regional governments, instead of granting tax incentives for new businesses, invest the equivalent sum in infrastructure in order to raise the regional attractiveness. The results of the simulations with different scenarios are presented in Figures 14, 15,16, 17 and 18.

You can see that in all scenarios proposed in the Southeast results most favorable than those observed in practice, while the Northeast got different results. In the absence of specific policies to attract private investment, the Northeast cannot mitigate this regional bias in the allocation of this resource, since the Southeast is naturally more attractive to investment (scenario 1).

On account of lower investment flows directed to the Northeast, the capital stock of the region has a lower growth trajectory. The trajectory of the capital stock has a negative effect on GDP in the Northeast. Regarding tax collection and infrastructure level, there is not a significant change in behavior. This is due to the absence of tax waivers. Because they are not granted tax incentives, reduced tax base (decrease of GDP) is offset by an increase in the percentage of capitation tax (no waivers). Thus, both the inflow and the infrastructure exhibit paths similar to those observed in practice.

The Southeast region has a crescent private investment flow, and therefore would not need to use their tax incentives. The only motivation in the Southeast to grant tax incentives is the Northeast, that have started this practice, i.e. the Southeast reacts to "attack" initiated by the Northeast in order to avoid losses of private capital. Thus, under the conditions of scenario 1, the Southeast expands investments, amount of capital, GDP, tax revenue and infrastructure, which tends to attract more private investment (positive spiral).

The standardization of state competence rates (Scenario 2) also restricts the room for maneuver in the Northeast. With the homogenization of tax burdens, the Northeast region reduces the amount raised and therefore the amount of investment in infrastructure. In return, the Southeast region increased its revenue and may increase investments in infrastructure. However, this standardization does not change the spatial distribution of the invested amount. For this reason, the result of scenario 2 does not produce very significant changes in relation to GDP, and we found a reduction of GDP Northeast and expansion of GDP in the Southeast.

In the third scenario the effect of the ban on tax incentives earn an additional: the standardization of tax burdens. In the case of the Southeast, the tax burdens further extends the storage, dispensing more resources for infrastructure investment (more attractive), without the need for tax waiver. The Northeast, on the other hand, gets the worst results in terms of flow of private investment, GDP and revenues. This is because, besides the absence of policies to attract investment, reduced revenue limits the volume of public investment in infrastructure, making the Northeast even less attractive for investment (scenario 3). Thus, the GDP of Northeast also stays any levels below those in other scenarios.

In the event that the amount of tax incentives is transferred to investment in infrastructure (Scenario 4), the results for the Northeast region are better than the scenarios that prohibit the granting of incentives. However, in relation to the flow of investment these results are still below the achieved levels in the region when practiced tax competition. The fact that incentives are not directly grant to investors make the Southeast the preferred location for making investments. So even though the Northeast can realize significant increases in the level of infrastructure, its disadvantage in attracting investment persists (success to succeed).

On the other hand, the gains made in infrastructure - Scenario 4 - increased values achieved by GDP, both the Northeast and Southeast, indicating that policies directed to the development of infrastructure tend to boost the economy's productive capacity. With this argument, Malliagros and Ferreira (1998), evaluated the effect of investments in infrastructure on TFP Brazilian find that there is a strong relationship between infrastructure and output in the long time. According to the authors, with the financial deterioration of the state, increasing indebtedness and acceleration of inflation, the state and public investment have a marked reduction, which cause a reduction in the GDP growth rate. Thus, the gap in the infrastructure levels has a very significant impact of the GDP.

Finally, the redirection of tax incentives in conjunction with the standardization of tax rates (scenario 5) results in a condition similar to scenario 4 in terms of attracting investment. But the above scenario reinforces the results of scenario 4, intensifying the expansion of GDP and stock of infrastructure in the Southeast, and mitigating its effect on the Northeast.

Although the scope of this study are not a long-term analysis, we can infer that with a constantly increase of infrastructure, the capital attractiveness of both regions also increases. That is not a sufficient condition for delay reduction compared to the Northeast. The sub national financial condition enrages the composition of public spending. Since there is already a push for the performance of governments in areas such as health and education, it becomes unviable to earmark a significant amount of resources for development of infrastructure. In addition there are also costs involved in coordinating these policies at regional level, with conflicting interests and opposition politicians. These factors fall into this problem within the theme of collective action, discussed in the previous chapter.

In the national point of view tax competition only results in loss of tax revenue and distortions in the efficient allocation of resources (investment decisions are not guided by differences in competitiveness), however in the regional point of view for marginalized regions industrial policy are an alternative for private investment. In the absence of a central action and planned reduction of regional disparities, the tax waiver is revealed as a practical tool with immediate result. It should be noted that according to the systemic model, the results obtained with the tax competition is not even optimal condition for the less favored resource (Northeast). Since, upon the incursion of specific investments in infrastructure (in the same amount of tax waivers), the behavior of GDP, infrastructure and revenue would be higher in this region.

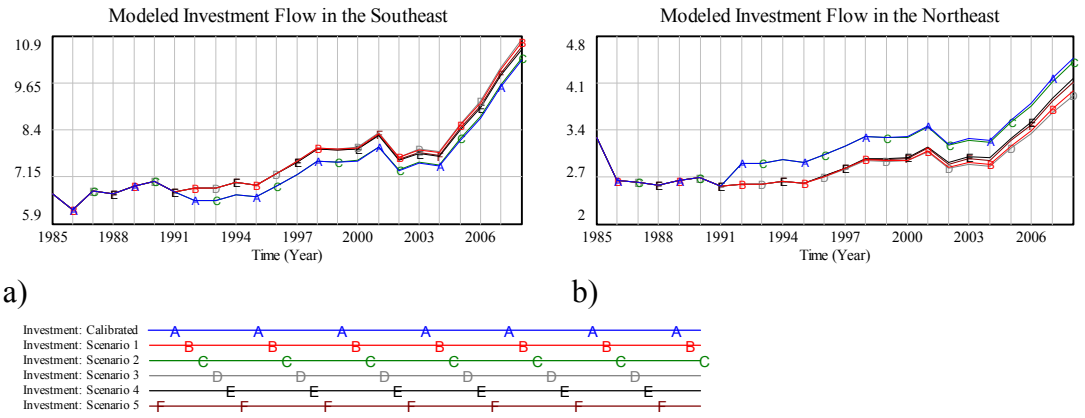


Figure 14 – Modeled investment flow for the Southeast and Northeast in the different scenarios, 1985-2005.
Source: Elaborated by the authors.

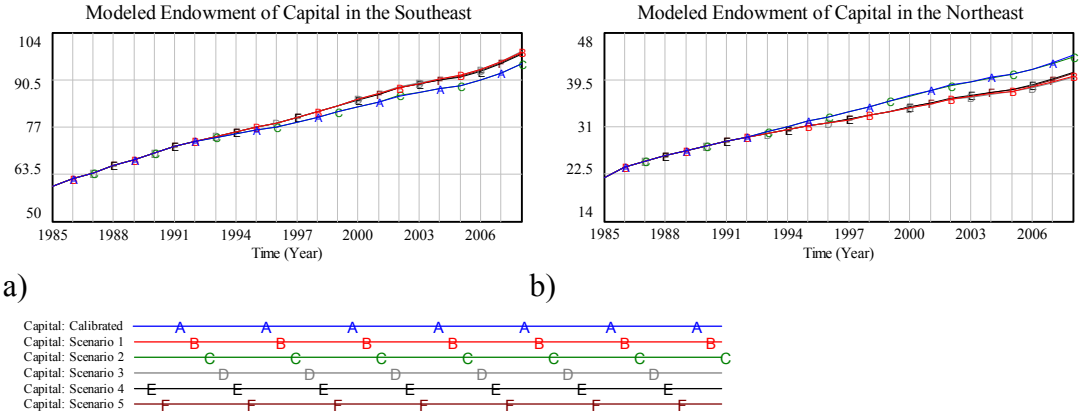


Figure 15 – Modeled capital stock in the Southeast and Northeast in the different scenarios, 1985-2005.
Source: Elaborated by the authors.

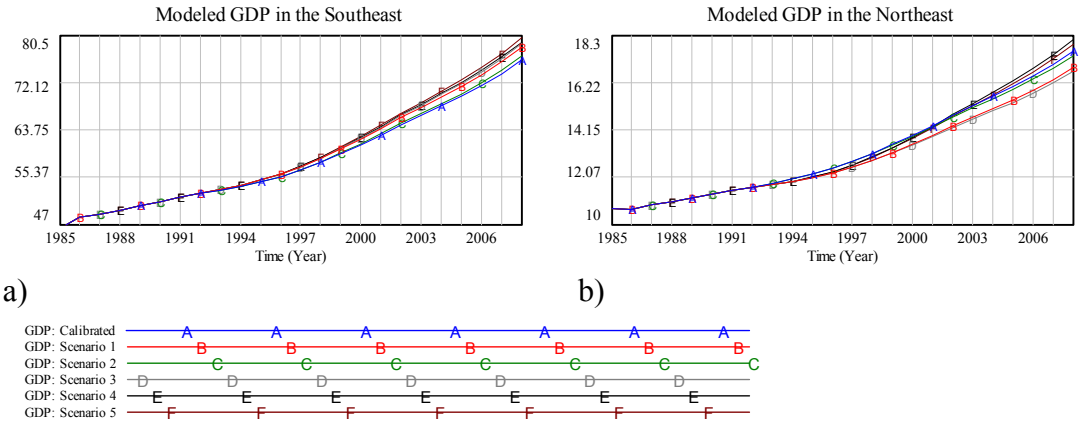


Figure 16 – Modeled GDP of the Southeast and Northeast in the different scenarios, 1985-2005.
Source: Elaborated by the authors.

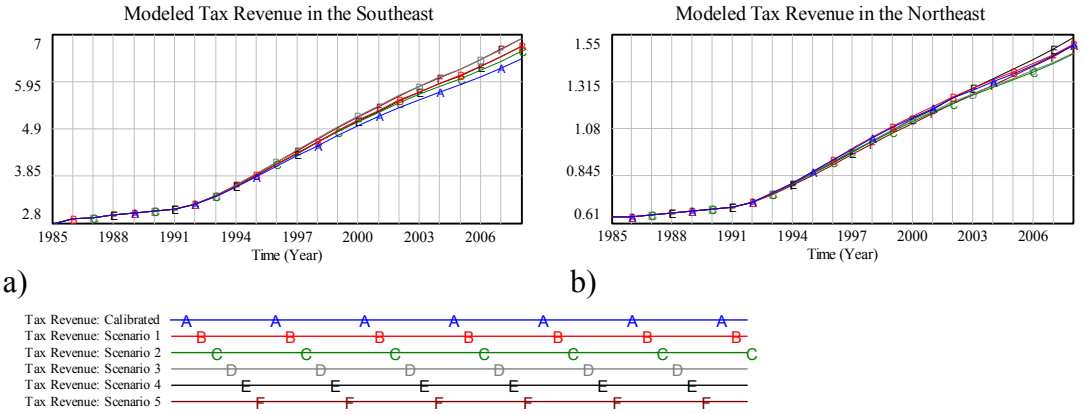


Figure 17 – Modeled tax revenue of the Southeast and Northeast in the different scenarios, 1985-2005.
Source: Elaborated by the authors.

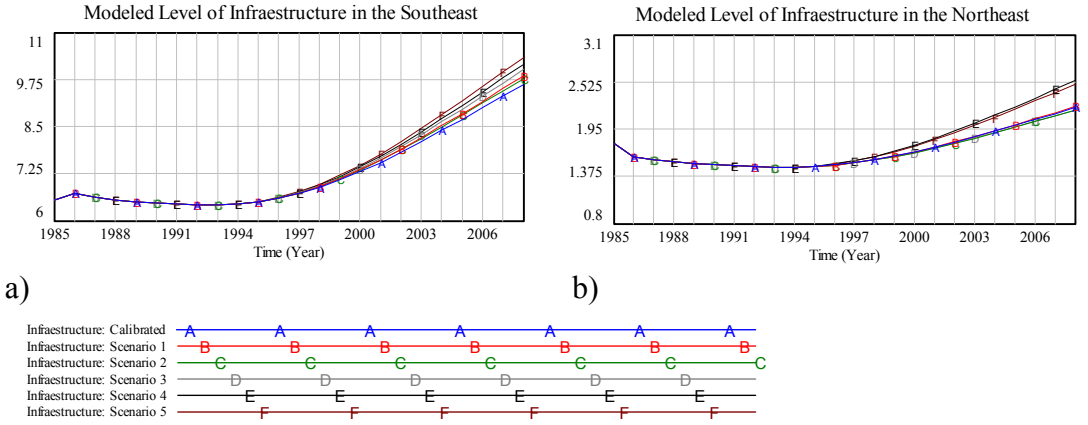


Figure 18 – Modeled level of Infraestructure in the Southeast and Northeast in the different scenarios, 1985-2005.
Source: Elaborated by the authors.

5. Conclusion

The use of tax competition has become customary in the Brazilian federation. Through the commitment of measures of fiscal and financial nature, sub national governments seek to reverse the centripetal tendency of Brazilian politics, which channels the flow of resources to the central regions. However, the lack of regulation means able to coordinate its implementation provides status of conflict with this phenomenon. In the present study seeking to analyze the interaction between systemic and institutional sources of tax competition in Brazil, aiming to identify the elements that perpetuate this practice and its effects on the economy.

The used system model indicates that in absence of tax competition, the peripheral regions (Northeast) receive a lower volume of private investment, resulting in a lower level of GDP. However, the scenario in which the volume of tax incentives (which would be potentially granted) are channeled in the form of public investment in infrastructure, it seen a trend of higher GDP growth of both regions. It should be noted that among the scenarios that are not granted tax incentives, this is the condition because the Northeast region has a higher flow of investment. However, its implementation is barred by the inability of regional governments to promote systematic investments in infrastructure, due to fiscal rigidity and coordination costs.

For this reason, it is evident that the sub national level (decentralized) is the only alternative industrial policy for less grant tax incentives. However, this type of policy is palliative and temporary and does not constitute, per se, a sustainable policy to fix the route of economic contraction. It remains the central government to put policies in place to increase the attractiveness of these regions for private investment. Otherwise, these regions do not have incentives to abdicate tax competition.

The proposed and analyzed model in this study captures regional disputes for new investments, but cannot measure the effect of mobility of investments already installed or to influence investment decisions across countries, i.e. that tax competition

is important for attracting foreign investment. Another aspect is that the analyzed model captures the aggregate behavior of tax competition between two regions. However, the main actors of this phenomenon are the states and municipalities, so it is important to analyze the nuances of the competition between various jurisdictions, which may have similarities (social problems, fiscal imbalance, lack of infrastructure, etc). Additionally, the model does not include mobility and heterogeneity of technical manpower (different levels of skilled labor). Further work may consider these presumptions and incorporate the above aspects.

References

ARBIX, G. Guerra Fiscal e Competição intermunicipal por novos investimentos no setor automobilístico brasileiro. **Dados** v.43 n.1. Rio de Janeiro, 2000.

ASSIS, Luciana C. de; DIAS, Joilson. **Política fiscal, nível tecnológico e crescimento econômico no Brasil:** teoria e evidência empírica. Disponível em: <www.anpec.org.br/encontro2004/artigos/A04A050.pdf>. Acesso em: 20 Out. 2008

BCB – Banco Central do Brasil. **Séries temporais**. Disponível em: <http://www.bcb.gov.br/>. Acesso em: 20 Jun. 2009.

BUENO, Newton Paulo. **Introdução à dinâmica de sistemas**. Viçosa: Ed. UFV, 2011.

_____. Institutions and natural resources sustainability in poor socio-ecological systems: closing some dynamical loops. **The Journal of Interdisciplinary Economics**. Vol. 21, 2009.

CASALI, Giovana F. Rossi. SILVA, Orlando Monteiro da. CARVALHO, Fátima M. A. Sistema regional de inovação: estudo das regiões brasileiras. **Revista de Economia Contemporânea,** Rio de Janeiro, vol.14 no.3 Sept./Dec. 2010

DULCI, O. S. Guerra fiscal, desenvolvimento desigual e relações federativas no Brasil. **Revista de Sociologia e Política**. N.18 Curitiba jun. 2002.

FERREIRA, Pedro Cavalcanti; MALLIAGROS, Thomas Georges. Impactos produtivos da infra-estrutura no Brasil – 1950/95. Pesquisa e Planejamento Econômico. Rio de Janeiro, v 28, n. 2, p 315-338, 1998. Disponível em: < http://ppe.ipea.gov.br/index.php/ppe/article/viewFile/708/648>. Acesso em: 09 fev. 2012.

FORRESTER, Jay W. **Industrial Dynamics**. Waltham, MA: Pegasus Communications , 1961, 464pp.

GIAMBIAG, Fábio... [et al.]. **Economia brasileira contemporânea.** Rio de Janeiro: Elsevier, 2005, p. 425.

GILBERT, N. and TROITZSCH, K. G. **Simulation for the Social Scientist**. Second edition. McGraw-Hill, Open University Press, 2006.

IPEADATA. **Dados macroeconômicos e regionais**. Disponível em: <

http://www.ipeadata.gov.br/>. Acesso em: 28 mai. 2011.

JERVIS, R. **System Effects:** Complexity in political and social life. Princeton, NJ: Princeton University Press, 1997.

KEEN, M.; MARCHAND, M. Fiscal competition and the pattern of public spending. **Journal of Public Economics 66**, 33-53, 1997.

KIM, D. H. **Systems thinking tools**: a user's reference guide. Waltham: Pegasus, 2000. p. 3 – 21.

LUPORINI, Viviane; ALVES, Joana. Investimento privado: uma análise empírica para o Brasil. **Economia e Sociedade**, Campinas, v. 19, n. 3 (40), p. 449-475, dez. 2010.

MANKIW, N. Gregory. **Macroeconomia**. 5º Edição . Rio de Janeiro: LTC, 2004. 379p.

MINTZ, Jack; TULKENS, Henry. Optimality Properties of Alternatives Systems of Taxataion of Foreign Capital Income. **Journal of Public Economics 60**, 373-399, 1996.

NASCIMENTO, S. P. Guerra fiscal: uma avaliação comparativa entre alguns estados participantes. **Economia Aplicada**. vol.12, n.4, pp. 677-706. 2008.

Ostrom, E. Collective action and the evolution of social norms. **Journal of Economic Perspective**, vol. 14 (3), 2000.

PAES, Nelson Leitão e SIQUEIRA, Marcelo Lettieri. **Reforma Tributária no Brasil: uma análise dinâmica dos efeitos macroeconômicos e dos impactos sobre a distribuição de renda e o bem-estar.** Brasília: ESAF. Monografia premiada em 2º lugar no IX Prêmio Tesouro Nacional – 2004, Tópicos Especiais de Finanças Públicas, Recife (PE), 2004. P. 80.

POCHMANN, Marcio. Velhos e novos problemas do mercado de trabalho no Brasil. **Indicadores Econômicos FEE**, Vol. 26, No 2, 1998.

ROCHA, Fabiana. GIUBERTI, Ana Carolina. Composição do gasto público e crescimento econômico: uma avaliação macroeconômica da qualidade dos gastos dos Estados brasileiros. **Econonmia Aplicada**, São Paulo, v. 11, n. 4, p. 463-485, outubro-dezembro, 2007.

SILVA, Tito Nícias Teixeira da. Searching for the Natural Rate of Unemployment in a Large Relative Price Shocks Economy: the Brazilian Case. **Working paper series**, No. 163, 2008, pp. 1-51.

SILVA, F. A. R.; OLIVEIRA, F. A. **Descentralização e federalismo fiscal no Brasil: desafios da reforma tributária**. Rio de Janeiro: FGV: Konrad-Adenauer-Stiftung, 2007.

STERMAN, John. **Businness dynamics**: systems thinking and modeling for a complex world. Boston: Irwin McGraw-Hill, 2000.

STN – Secretaria do Tesouro Nacional. **Execução Orçamentárioa por estado**. Disponível em: <http://www.tesouro.fazenda.gov.br/>. Acesso em: 28 mai. 2011.

WILDASIN, David E. Fiscal competition for imperfectly-mobile labor and captal: a comparative dynamics analysis. **Journal of Public Economics 95**, 1312-1321, 2011.

WILSON, John Douglas. WILDASIN, David E. Capital tax competition: bane or boon. **Journal of Public Economics 88**, 1065-1091, 2004.

_____. Mobile Labor, Multiple Tax Instruments, and Tax Competition. Journal of Urban Economics 38, 333-356, 1995.

VENSIM® – VENTANA SYSTEMS. **Vensim User's Guide:** version 5. Inc., Massachucetts, 2007. Disponível em: < http://www.vensim.com/causal.html>. Acesso em: 18 fev. 2011.

VIOL, A. L. **O fenômeno da competição tributária: aspectos teóricos e uma análise do caso brasileiro**. Brasília: ESAF, 1999. 79 p. Monografia vencedora em 1º Lugar no IV Prêmio de Monografia - Tesouro Nacional, Tópicos Especiais de Finanças Públicas, Brasília (DF), 1999.

ZODROW, G.; MIESZKOWSKI, P. (1986). Pigou, Tibout, Property taxation, and the underprovision of local public goods. **Journal of Urban Economics 19**, 356-370, 1986.