

The impacts of trade liberalization and integration strategies on Brazilian economy.

(Working in progress)

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Abstract

This paper aims to present the CGE model developed and implemented in order to evaluate the changes in employment, output and macroeconomic variables associated with distinct trade liberalization and integration strategies at national and state levels. Once we have obtained the estimates for the Brazilian economy, a top-down disaggregation is used to estimate the impacts on its 27 states. The model will indicate what would be the macro, sectoral and spatial effects on Brazilian economy if a specific were implemented, giving conditions to compare effects and shedding light on choice decision among alternative trade and integration strategies, since each trade agreement would entail different impacts on national economy and on its 27 sub-national spaces.

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Resumo

I. Introduction

Form the late 80's, have been occurring a swing towards an outward-looking development strategy in Brazilian economy. Last decade have witnessed a wave of neoliberal policies in Brazil, starting with Mercosur Agreement and unilateral liberalization. Regional integration have started with Mercosur in the early 90's and, in recent years, have been extended to other trade blocks, still under negotiation, is the major component of the process of unilateral liberalization of Brazilian economy.

The impact due the adoption of a specific trade strategy on any sector and/or economic agent will affect others sectors and agents due to interrelation (supply-demand relations) between sectors and economic agents, that is, the first impact will diffuse through sectoral dimension of the economy. As Brazilian economy presents an internal heterogeneity, with sub-national spaces presenting very different economic structure of production and trade, any national impacts will diffuse through spatial dimension of the economy. In this sense, the effects due to adoption of any integration and liberalization strategy on sectoral and spatial dimension of the economic must not be ignored, since these effects can make structural and spatial disparities become deeper among internal regions.

Thus, this paper aims to present a model developed to evaluate the short and long run changes in employment, output and macroeconomic variables associated with distinct trade liberalization and integration strategies, at national and state levels, using a multi-regional and multi-sectoral CGE model, considering distinct skills of labor³.

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Deleted: I.1. Motivação¶

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³ This methodology were choosed based on Hertel (1990).

Modeling issue

In the specification of linkages between national and regional economy, two basic approaches are prevalent, top-down and bottom-up methods, and the choice between them reflects a trade-off between theoretical sophistication and data requirements⁴. The top-down approach consists of disaggregating national results into their regional components, on *ad hoc* basis, with a desired adding-up property in a multi-step computation that, at each stage, the disaggregated projections are consistent with the results at immediately higher level. The starting point of top-down method are economy-wide projections and the decomposition of these results to regional dimensions occur without feedback from the regional level. In this sense, the effects of policies originating in the regional level are precluded. In accordance with the less theoretical sophistication in modeling the behavior of regional agents, most top-down models have minimal demand on regional data, comparing to bottom-up models which are more sophisticated and present heavy demand on regional data.

In the bottom-up approach, regional agents' behavior is explicitly modeled. A fully interdependent system must be specified in order to national-regional feedback may occur in both directions. Thus, analysis of originating at the regional level are facilitated. Since national results are obtained by the aggregation of regional results, the adding-up property is recognized.

How input-output tables of Brazilian states are not available and regional parameters, such as interregional trade elasticities, are rarely available in the literature, the strategy adopted utilizes a national CGE model with a top-down block of equations to evaluate the national effects of trade policies and to disaggregate them in their state-components.

Data requirements for the implementation of this top-down model were obtained using information of many surveys in order to construct a state level data base compatible with national data. The procedures and assumptions adopted will be presented below.

2. The model

Core module

In order to evaluate the effects of liberalization scenarios (full liberalization and regional agreements with Mercosur, Nafta and European Union) on Brazilian economy and on its 27 states, a national CGE model with a top-down methodology was developed and implemented. The **PRI** model is a forward-looking model specified for running comparative static simulations. The structure of PRI model represents an extension of the ORANI-G model⁵, that focuses on the disaggregation of its external sector

⁴ Liew (1984).

⁵ Dixon *et al* (1982).

in four regions, on the incorporation of a block of equations, which disaggregate the national impacts of policy changes in their sub-national components, and on the demand decision, which occurs in three stages.

PRI identifies 80 commodities, 42 sectors, 2 margin commodities (transportation and trade services), 2 types of labor (unskilled and skilled), 5 different group of users (producers, investors, households, foreigners and “other demand”, which includes Government), 27 states and 5 regions (Brazil, Mercosur, Nafta, European Union and Rest of the World).

Figure 1 represent the basic production technology adopted in PRI. Colored boxes represent functional forms used at each stage. Producers in each sector (industry) choose input requirements per unit of output through minimizing cost behavior. Constraints are given by the nested production technology. Fixed proportion combinations of intermediate inputs and primary factors are assumed in the first level. In the second level occurs the substitution between domestically produced and imported composite, on one side, and substitution between capital and labor, on the other side. At third level, bundles of imported inputs are formed as combinations of commodities from external regions, on one side, and the bundle of labor are formed as combination of skilled and unskilled workers. The specification adopted uses a constant elasticity of substitution (CES) function to combine goods from different sources and labor with distinct skills.

The treatment of the household demand structure, depicted in Figure 2, is based on a nested CES/Klein-Rubin preference function. Demand equations are derived from a utility maximization problem, whose solution occurs in three stages. First, the family decides his demand composition among commodities. Then, decides the composition of each commodity demand between domestic and imported composite commodities, and finally, choose the composition of imported composite between commodities from foreign regions. The demand structure of investment decision is also depicted in Figure 2, and is self-explanatory.

Figure 1: Nesting structure production

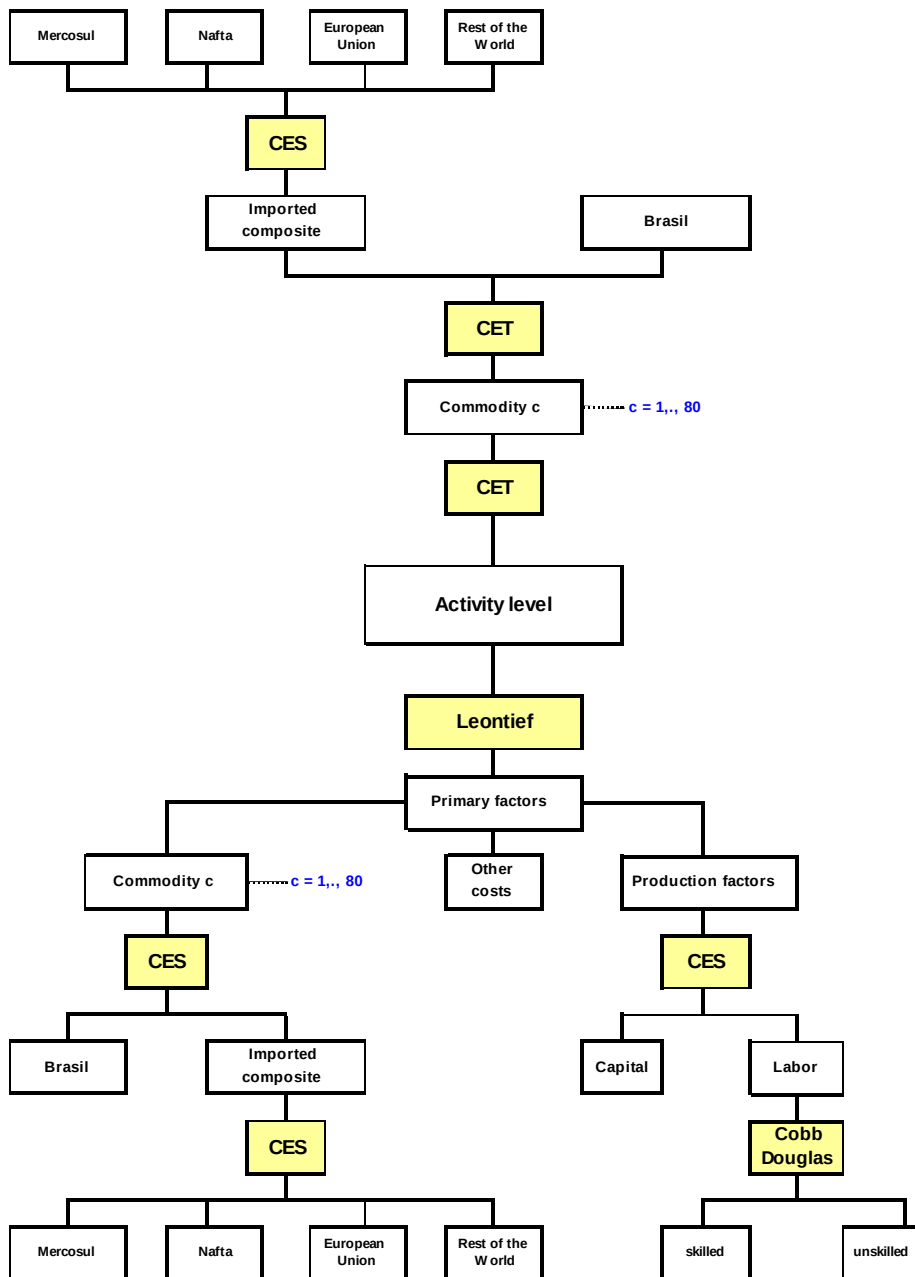
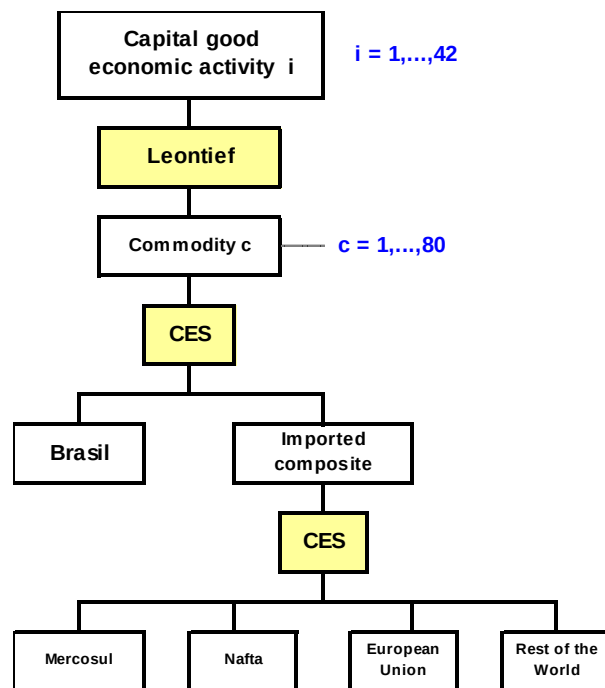
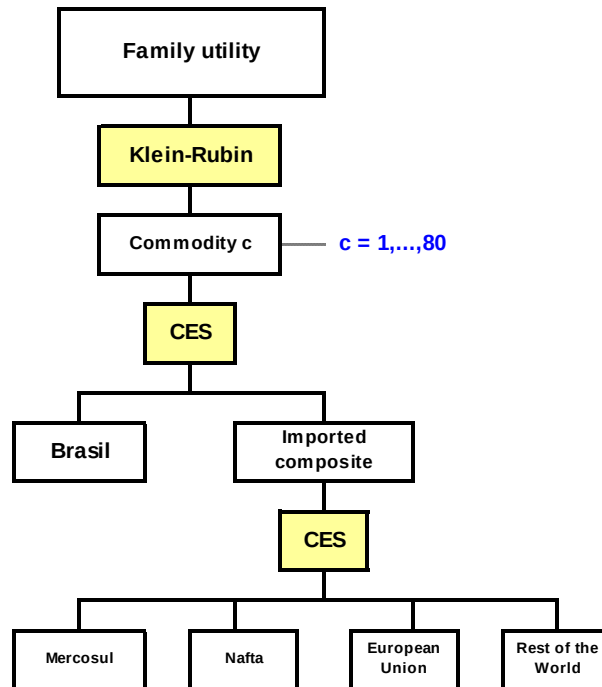


Figure 2: Nesting structure of household and investment demand



Equations for other final demand for commodities include the specification of export demand and “other” demands, which include government. Exports are divided into two groups: traditional exports (agriculture, mining, coffee and sugar) and non-traditional exports. The former faces downward sloping demand curves, indicating that it exists a negative relation between traditional exports and their prices in the world market. Non-traditional exports form a composite tradable bundle, in which commodity shares are fixed, and demand is negatively related to the average price of this bundle. Moreover, the specification of export demand equations consider the fact that exports are provided by domestic and foreigners producers.

Concerning to top-down methodology, the allocation of commodities into national or local categories relies on the ability of the state industry to supply the demands placed upon it by other industries in the state and state final demand. If the participation of industry production in some state in the regional product is less than the participation of regional industry in the economy-wide output of this industry, is assumed that the demand in the state is satisfied mainly from production in that state, and this industry is classified as state industry and the commodities which it produces as state commodities. On the other hand, is assumed that the commodity(ies) it produces is extensively traded with other states. In this case, at this state, this industry is classified as national industry and the commodities which it produces as national commodities.

National industries at state level experiments same effects on economy-wide industry, while to state (local) industries, production experiments the effect on economy-wide industry but its production in each state equals demand in this state.

Mathematical structure and solution method

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The mathematical structure and equations of PRI are based on the ORANI-G Model (Dixon *et al*, 1982), with additional equation module to disaggregate the national impacts in their sub-national components. So it qualifies PRI as a Johansen-type model in that the solutions are obtained by solving the system of linearized equations of the model. A typical result shows the percentage change in the set of endogenous variables, after a policy is carried out, compared to their values in the absence of such policy, in a given environment. The schematic presentation of Johansen solutions for such models is standard in the literature and what follows is a summary of its contents in order to see how these models work⁶.

In Johansen approach, the system of equations (the model) can be written as

$$\mathbf{F}(\mathbf{V}) = 0 \quad (1)$$

⁶ More details can be found in Dixon *et al*. (1982, 1992), Harrison and Pearson (1994, 1996), and Dixon and Parmenter (1996).

where V is an equilibrium vector of length n , and F is a vector function of length m , which is assumed to be differentiable. The vector V contains economic variables like quantities, prices, taxes and technological coefficients, while economic relations present in the system (1) are comprised of equations representing household and other final demand for commodities, equations for intermediate and primary factors inputs, pricing equations relating commodity prices to cost, market clearing equations for primary factors and commodities, among others. Regarding the system dimensions, it is assumed that the total number of variables (n) is greater than the total number of equations (m). Thus the system is possible (it has solution), but it is not determined (it has infinite solutions). Then, the value of $(n - m)$ variables must be set exogenously in order for the system (1) to have a unique solution.

For the purpose of the calibration of the model, it is assumed that an initial solution, V^* , is known, this is, $\exists V = V^*$ with which we have $F(V^*) = 0$.

For PRI, the vector V^* is read from the data base designed from the national input-output tables for Brazil and using some other surveys in order to have a compatible state level data base. Given the initial solution, V^* , the initial step of the approach used to compute a new set of solutions to the model is divide variables in exogenous and endogenous categories⁷. Let $V1$ be the vector of m endogenous variables and $V2$ be the vector of $(n - m)$ exogenous variables. Thus, system (1) can be rewritten as

$$F(V1, V2) = 0 \quad (2)$$

By totally differentiating (2) and evaluating at V^* , we get

$$F_1(V^*)dV1 + F_2(V^*)dV2 = 0 \quad (3)$$

where F_1 and F_2 are matrices of partial derivatives of F evaluated at V^* . Solving (3) for $dV1$, we have

$$dV1 = \left[-F_1^{-1}(V^*)F_2(V^*) \right] dV2 = B(V^*)dV2 \quad (4)$$

It is assumed that the relevant inverse, $F_1^{-1}(V^*)$, exists at least for the question of interest⁸.

Linearization errors

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Because $B(V^*)$ is the matrix of the first-order partial derivatives of F , evaluated at the initial solution of the model, V^* , the solution achieved by the method described above represents an approximation of the “true” solution. How as one moves away from V^* , the partial derivatives of F are also moving (changing), this fact produces errors between the model solution got with this method and the “true” solution derived from any change in the initial values in set of exogenous variables, due to the linearization of the equations of the model.

⁷ Considering the one-step Euler or Johansen solution.

⁸ Dixon and Parmenter (1996)

To solve this problem and, thus, getting more accurate results, is introduced a multi-step solution procedure, in which the exogenous shock is divided in p equal parts. Then, a sequence of Johansen-style computations is used, in which the matrix B is reevaluated at each step. Dixon *et al.* (1982) show that one can be confident that as p approaches infinity, multi-step Johansen method will produce an exact solution. Moreover, in order to get a more accurate solution it were used the Gragg's method, supplemented by an extrapolation procedure.

Closure

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PRI can be configured to make short and long run comparative static. At this stage, two basic closures for alternative time frames of analysis in single-period simulations are available. A distinction between the two closures concerns to the treatment of capital stocks in the standard microeconomic approach to policy adjustments. In the short-run closure, capital stocks are held fixed, while, in the long run, it can occur adjustment of capital stocks due to policy changes.

3. Data base

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National level

The national data were directly obtained from Input-Output tables from Brazilian Institute of Geography and Statistics (IBGE), except external trade and associated flows (basic, margin usage and taxation), sectoral employment of labor by skill and sectoral investment data. The subjacent idea in the methodology used to obtain these data is use information on distribution of equivalent data from other surveys to disaggregate data from IO national tables.

External trade with specific regions

The external trade data (T) presented in IO tables are commodity (c) and flow (f) specific, ($T(c,f)$), but the model also request the identification of the region of origin of imports (r) and the region of destination of exports (r), ($T(c,f,r)$). This identification were made using external trade data classified by Nomenclatura Brasileira de Mercadorias – Sistema Harmônico (NBM-SH) from Commerce Ministry using the equation:

$$T(c, f, r)^* = T(c, f)^* \sum_{c^N \in C^N} T(c^N, r)^* \left[\sum_{r \in R} \left(\sum_{c^N \in C^N} T(c^N, r) \right) \right]^{-1},$$

where c^N is (are) the NBM-SH commodity(ies) equivalent(s) to each commodity in IBGE code.

Employment and wage by skill

The original data present total labor employed (L) and wage mass (S) paid by sector, but the model request data on labor employment by skill (skilled and unskilled) and the correspondent wage mass, which were obtained from distribution of labor by skill and wages through sectors (i) obtained from information contained in *Relação Anual de Informações Sociais (RAIS)* and *Pesquisa Nacional por Amostra de Domicílios (PNAD)*, which are national surveys. Workers with at most 8 years of schooling (e) were considered unskilled, and the others as skilled. Thus, the employment level of labor by skill were obtained using:

$$L(i, nq) = L(i) * \left[\sum_{i^* \in I^*} \sum_{e \leq 8} L(i^*, e) \right] * \left[\sum_{i^* \in I^*} \sum_{e \in E} L(i^*, e) \right]^{-1}, \text{ and}$$

$$L(i, q) = L(i) * \left[\sum_{i^* \in I^*} \sum_{e > 8} L(i^*, e) \right] * \left[\sum_{i^* \in I^*} \sum_{e \in E} L(i^*, e) \right]^{-1},$$

where I^* is the set of economic activities (i^*) in RAIS, which are equivalent to each economic activity i (sector) in the IBGE code, and E is the set of years of schooling.

The correspondents mass of wages paid to workers were obtained from:

$$S(i, nq) = S(i) * \left[\sum_{i^* \in I^*} \sum_{e \leq 8} (L(i^*, e) * S(i^*, e)) \right] * \left[\sum_{i^* \in I^*} \sum_{e \in E} (L(i^*, e) * S(i^*, e)) \right]^{-1}, \text{ and}$$

$$S(i, q) = S(i) * \left[\sum_{i^* \in I^*} \sum_{e > 8} (L(i^*, e) * S(i^*, e)) \right] * \left[\sum_{i^* \in I^*} \sum_{e \in E} (L(i^*, e) * S(i^*, e)) \right]^{-1}.$$

Investment flows

The original data on investment flows and correlated flows of usage of margin services and indirect tax presented by IO national tables are commodity (c) and source (s – domestic and imported) specific - $I(c, s)$, but model requests data also specific by sector (i) and external source.

The capital stock at sector i in year t and, $(K(t, i))$ equals sum of its capital stock in year $t-1$, $(K(t-1, i))$ and gross investment done in t , $(I_B(t, i))$:

$$K(t, i) = K(t-1, i) + I_B(t, i).$$

Gross investment done in t , $(I_B(t, i))$, equals the net investment done in t , $(I_L(t, i))$, plus depreciation occurred in t , $(D(t, i))$:

$$I_B(t, i) = I_L(t, i) + D(t, i).$$

This depreciation expenditure is done in order to compensate the share of capital stock consumed by production process:

$$D(t, i) = \delta(t, i) * K(t-1, i),$$

where $\delta(t, i)$ is the depreciation rate.

The ratio between capital stock and output ($Q(i)$) in each sector i is given by:

$$\alpha(i) = \frac{K(t, i)}{Q(t, i)} = \frac{K(t-1, i)}{Q(t-1, i)}.$$

Considering changes in prices:

$$K(t-1, i)[(p_t)] = \left[\frac{(p_t)}{(p_{t-1})} \right] * K(t-1, i)[(p_{t-1})] = \pi_t * K(t-1, i)[(p_{t-1})]$$

where π_t is the inflation rate in year t . Thus, one have:

$$I(t, i) = \alpha(i) * [Q(t, i) - (1 - \delta) * \pi_t * Q(t-1, i)].$$

Suppose that exists a representative capital commodity (k), one can obtain investment flows by source (domestic and imported), ($I(s)$):

$$I(s) = \sum_{c \in C} I(c, s) = \sum_{c \in C} \left(\sum_{i \in IND} I(c, s, i) \right),$$

where C is the commodity set and IND is the sector set. A second assumption is that investment flows composition by commodity in each activity i is the same and follows the commodity share in total investment ($k(c, s)$):

$$k(c, s) = \frac{I(c, s)}{I(s)}.$$

The third assumption consists of considering that capital stock-output ratio in each sector is the same in both years, whose values were estimated by Moreira (1992). It was also assumed that the depreciation rate is 3% by year⁹, for all sectors. With these assumptions and levels of sectoral output in 1995, ($Q(t-1, i)$), and 1996, ($Q(t, i)$), one can obtain the sectoral aggregate investment:

$$I(t, s, i) = \sum_{c \in C} I(t, c, s, i) = \alpha(i) * \{Q(t, i) - [(1 - \delta) * \pi_t * Q(t-1, i)]\}.$$

The composition of sectoral investment by commodity and source (domestic and imported) was obtained by:

$$I(t, c, s, i) = \left[\sum_{c \in C} I(t, c, s, i) \right] * k(c, s) = I(t, s, i) * k(c, s).$$

⁹ (Moreira, 1992, p.429)

In order to recognize the specific external region from where commodity was imported, it was used the equation:

$$I(t, c, r, i) = I(t, c, s_{\text{ext}}, i) * \left[\sum_{c^N \in C^N} M^N(c^N, r) \right] * \left[\sum_{r \in R} \left(\sum_{c^N \in C^N} M^N(c^N, r) \right) \right]^{-1}.$$

To disaggregate the margin usage and taxes flows related to investment flows done with commodity c by sectors i , it was assumed that their distribution follow the composition by sector of investment done with this good. Thus, the margins usage were disaggregated using the equation below:

$$M(c, s, i, m) = \frac{I(c, s, i)}{\sum_{i \in \text{IND}} I(c, s, i)} * \left[\sum_{i \in \text{IND}} M(c, s, i, m) \right] = \frac{\sum_{i \in \text{IND}} I(c, s, i)}{\sum_{c \in C} \left(\sum_{i \in \text{IND}} I(c, s, i) \right)} * \sum_{c \in C} \left(\sum_{i \in \text{IND}} M(c, s, i, m) \right)$$

where $M(c, s, i, m)$ is the use of margin service m in investment flow done by sector i using commodity c provided by source s . In order to disaggregate the margin usage associated to investment flows done with imported commodities, by specific external region, it was used the equation below:

$$M(c, r, i, m) = M(c, s_{\text{ext}}, i, m) * \left[\sum_{c^N \in C^N} M(c^N, r) \right] * \left[\sum_{r \in R} \left(\sum_{c^N \in C^N} M(c^N, r) \right) \right]^{-1}.$$

The disaggregation of indirect taxes flows associated to investment was done following the same methodology used to disaggregate the usage of margin services. In this sense, it was done with follow equation:

$$T(c, s, i) = I(c, s, i) * \left[\sum_{i \in \text{IND}} I(c, s, i) \right]^{-1} * \left[\sum_{i \in \text{IND}} T(c, s, i) \right] = \sum_{i \in \text{IND}} I(c, s, i) * \left[\sum_{c \in C} \left(\sum_{i \in \text{IND}} I(c, s, i) \right) \right]^{-1} * \sum_{c \in C} \left(\sum_{i \in \text{IND}} T(c, s, i) \right),$$

where $T(c, s, i)$ is the tax revenue.

State level

Trade flows

The commodity and external region specific trade flows, $T(j, c, r)$, of each state j were obtained with the equation:

$$T(j, c, r) = T(c) * \left[\sum_{c^N \in C^N} T(j, c^N, r) \right] * \left[\sum_{j \in J} \left(\sum_{r \in R} \left(\sum_{c^N \in C^N} T(j, c^N, r) \right) \right) \right]^{-1}.$$

Consumption of families

The Brazilian System of National Accounts present data for commodity specific consumption of families flows, $(CF(c))$, but in order to evaluate the impacts of trade strategies on consumption in each state, one needs data which recognize the state (spatial) dimension of these flows – $(CF(c, j))$ is needed. In order to obtain these data, firstly, it was calculated the family income in each state, $(R(j))$, using data from Pesquisa Nacional por Amostra de Domicílios (PNAD, 1996), cited early, and the equation:

$$R(j) = \sum_{i=1}^n N_i(j) * R_i(j)$$

where $N_i(j)$ is the number of families which receive the income $R_i(j)$. With the assumption that the income share allocated to consumption by state family do not depend of geographical location in country, that is, is the same for all states, the state family share in national consumption is:

$$r(j) = R(j) * \left[\sum_{j \in J} R(j) \right]^{-1}.$$

Thus, the state family consumption levels were obtained by:

$$CF(j) = r(j) * \sum_{c \in C} \sum_{s \in S} CF(c, s).$$

In order to get commodity-source specific flows of family consumption in each state, $(CF(c, s, j))$, it was used family expenditure data from Pesquisa de Orçamento Familiar (1996), which is a budget-expenditure survey done in 11 of the 27 capitals of states. Thus, it was supposed that the state consumption composition is similar to composition of its capital, for states where this survey is collected. In relation to states, where this survey is not collected, it was assumed that their consumption composition is similar to the nearest neighbor state. With these assumptions, the commodity-source-state specific family consumption flows were obtained with:

$$CF(c, s, j) = CF(j) * CF(c^*, j^*) * CF(c, s) * \left[\sum_{s \in S} CF(c, s) \right]^{-1},$$

where c^* is the commodity in POF which is equivalent to commodity c in IBGE code, and j^* is the metropolitan area which is the reference to state j .

Production

The production composition by state for 12 of 42 economic activities¹⁰ were directly obtained from Regional Accounts System. The other 30 activities are associated to mining and transformation industry. Thus, their production composition by state were obtained in a second step from of Pesquisa Industrial Anual (PIA), which is a industrial survey. The data collected in 3 states are perfectly compatible with IBGE code, and their information were used in direct way. To other 24 states, it was necessary make a translator in order to make data compatible. Thus, the state share in the output of that 30 sectors i^* associated to mining and transformation industry could not be obtained directly from PIA data. In these cases, it was assumed that the production technology adopted in each activity was the same at each state. Then, the average labor productivity will be the same in each state, and the state share in national output for each activity will be proportional to state share in national employment of labor, that is, the share of state j in output of sector i^* is:

$$P(i^*, j) = \sum_{j \in J} P(i, j) * \left[\frac{L(i, j)}{\sum_{j \in J} L(i, j)} \right],$$

where $L(i, j)$ is the employment level of labor in sector i in state j .

¹⁰ Agriculture, public services (energy), construction, trade, family services, transportation, communication services, financial institutions, firm services, rent services, public administration and private non-tradable services.

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