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REGIONAL IMPACTS OF TRADE LIBERALIZATION STRATEGIES IN BRAZIL

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SUMÁRIO

ABSTRACT

There is a great interest in free trade areas (FTA) in Brazil, predominantly in the context of a proposed Free Trade Area of the Americas (FTAA). In addition, a free trade area between MERCOSUR (the customs union involving Brazil, Argentina, Uruguay, and Paraguay) and the European Union has also been considered. In this paper, an interregional computable general equilibrium (CGE) model is used to analyze the long-run regional effects of alternative trade liberalization strategies on Brazil. The model provides a description of the Brazilian inter-regional economic system, divided into two regions - Sao Paulo and Other Regions in Brazil. One of its innovations is a full specification of foreign trade in both regions, capturing the complete structure of trade flows and import tariffs, linking the two Brazilian regions and a set of foreign markets. In this way, adequate simulations of tariff liberalization can be implemented for several possibilities of trade agreements.

Keywords: computable general equilibrium, regional models, trade policy, Brazil.

RESUMO

O objetivo deste trabalho é avaliar, ex-ante, implicações setoriais e regionais de uma políticas de integração comercial para o Brasil. Para isso, um modelo inter-regional de equilíbrio geral computável é utilizado, de forma a possibilitar, num quadro consistente, a implementação de simulações de acordos comerciais. Os resultados obtidos projetam um efeito positivo das liberalizações tarifárias para o crescimento do Produto Interno Bruto e geração de superávit comercial, no longo prazo. Territorialmente, entretanto, os impactos atuam no sentido da concentração relativa da produção e investimento. Além disso, uma importante diferenciação setorial dos impactos da liberalização comercial pode ser identificada.

JEL: C68, C63

1. INTRODUCTION[1]

A cost-competitiveness approach - based on relative changes in the sectoral and regional cost and demand structures - is adopted to isolate the likely effects of trade policies in Brazil. Cumulative causation appears through the operation of internal and external multipliers and interregional spillover effects in comparative-static experiments, such as those proposed here.

This paper employs an interregional computable general equilibrium (CGE) model to analyze the short-run and long-run regional effects of regional trade policies, represented by simulations of changes in bilateral import tariffs, on the Brazilian economy. The model produces estimates for two Brazilian sub-national spaces, designated as "regions", using the bottom-up approach (national results are obtained from the aggregation of regional results). An applied general equilibrium approach to study trade policy issues at intracountry level is not new in the literature. Haddad (1999) and Haddad *et alli* (2002) have studied the Brazilian case.[2]

Modeling Issue

The specification of links between national and regional economies represents an interesting theoretical issue in regional modeling. Two basic approaches are prevalent – top-down and bottom-up –, and the choice between them usually reflects a trade-off between theoretical sophistication and data requirements.

The top-down approach consists of a disaggregation of national results into regional levels on an ad hoc basis. This disaggregation can be made through different steps (e.g. country-state - municipality), and enhanced up to a very fine level of regional divisions. The desired adding-up property in a multistep procedure is that, at each stage, the disaggregated projections have to be consistent with the results at the immediately higher level. The starting point of top-down models are economy-wide projections. The mapping to regional dimensions occurs without feedback from the region; in this sense, effects of policies originating in the regions are precluded. In accordance with the lack of theoretical refinement in terms of modeling the behavior of regional agents, most top-down models are not as data demanding as bottom-up models.

In the bottom-up approach, the agents' behavior is explicitly modeled at the regional level. A fully interdependent system is specified in which national-regional feedback may occur in both directions. Thus, analysis of policies originating at the regional level is facilitated. The adding-up property is fully recognized, since national results are obtained from the aggregation of regional results. In order to make such highly sophisticated theoretical models operational, data requirements are very demanding. To start with, an interregional input-output database is usually required, with full specification of interregional flows. Data also include interregional trade elasticities and other regional parameters, for which econometric estimates are rarely available in the literature.

[1] This section draws on Haddad and Domingues (2002) and Domingues and Haddad (2003).

[2] For a survey about regional and CGE modeling, see Partridge and Rickman (1998).

The strategy adopted in this paper utilizes an interregional computable general equilibrium (CGE) model to evaluate shifts in the economic activity and investment in the Brazilian economy due to alternative trade policies. Endogenous inter-regional trade and relative price changes, due to changes in foreign trade taxes, can be modeled trough CGE models. Besides, input substitution, regional investment movements, and labor market implications are also taken into account in the analysis. An important advantage of using these models is that economic agents do respond to relative price changes, and therefore the system is fully endogenous.

This paper has four parts, in addition to this introduction. In the second part the methodology employed is explained. Simulations and results are discussed in the third part. Finally, the fourth part brings concluding comments about the paper.

2. METHODOLOGY

Table 1 brings selected indicators about the rough regionalization assumed in this paper for Brazil, divided into Sao Paulo and Other Regions. Sao Paulo is the largest state economy in Brazil, if we consider its share on Gross Domestic Product (around 35%) and total population (more than 20%). Domestic trade flows indicate the prominent role of Sao Paulo in the interregional system, with larger shares compared to the rest of Brazil.[3] It is worth noting that interregional trade is much larger than foreign trade. Although this stylized fact is known in the literature, its consequences are usually not taken into account.

TABLE 1

Selected Indicators, 1996

			Brazil	Sao Paulo	Other Regions
GDP share			-	35.76	64.24
Population share			-	21.22	78.78
Flows*	Foreign Trade	Exports	6.44	6.48	6.42
		Imports	7.71	7.00	8.11
	Domestic Trade	Exports	-	42.55	14.83
		Imports	-	26.64	23.69

Source: Domingues (2002)
* GRP share in each region, GDP share for the national economy

In order to study the effects of alternative trade policies in an integrated interregional system, a CGE model for two regions in Brazil, Sao Paulo state and other regions, is employed. The SPARTA Model (**S**ao **P**aulo **A**pplied **R**egional **T**rade **A**nalysis **M**odel) is a fully operational interregional CGE

[3] Sao Paulo has the largest surplus on interregional trade among the 27 Brazilian states. For a study of the interstate trade structure in Brazil, and its change over the period 1985-1997, see Domingues *et al.* (2002). Among others, Azzoni (2001) and Diniz (1999) have studied recent regional changes in the Brazilian economy.

model for Brazil. The model is based on the B-MARIA Model [4]. SPARTA contains over 320,000 equations, and it is designed for forecasting and policy analysis.[5] The agents' behavior is modeled at the regional level, accommodating variations in the structure of regional economies. The model recognizes the economies of two Brazilian regions: Sao Paulo and Other Regions(residual). Results are based on a bottom-up approach – national results are obtained from the aggregation of regional results. The model identifies 42 sectors in each region producing 42 goods, a single household in each region, regional governments and one federal government, and seven foreign markets which trade with each region. Special groups of equations define government finances, accumulation relations, and regional labor markets. The model is calibrated for 1996, representing the economic structure after important macroeconomic policies in Brazil, such as the trade reform, initiated in 1990, and the stabilization plan (1994). Details about the database estimation and calibration are in Domingues (2002).

Next, the modules and specification of the SPARTA Model are summarized. We tried to pay attention to model features that are more important to the issues and simulations implemented in this paper. A full description of very similar models can be found in Haddad (1999) and Peter *et al.* (1996). The core equations and variables of the model are listed in **Appendix 1.** A miniature version of the model, for evaluation and testing, is available from the authors.

CGE Core Module

The basic structure of the CGE core module comprises three main blocks of equations determining demand and supply relations, and market clearing conditions. In addition, various regional and national aggregates, such as aggregate employment, aggregate price level, and balance of trade, are defined here. Nested production functions and household demand functions are employed; for production, firms are assumed to use fixed proportion combinations of intermediate inputs and primary factors are assumed in the first level while, in the second level, substitution is possible between domestically produced and imported intermediate inputs, on the one hand, and between capital and labor, on the other. At the third level, bundles of domestically produced inputs and imported ones are formed as combinations of inputs from different regional and imported sources. The modeling procedure adopted in SPARTA uses a constant elasticity of substitution specification (CES) in the lower levels to combine goods from different sources.

The treatment of the household demand structure is based on a nested CES/linear expenditure system (LES) preference function. Demand equations are derived from a utility maximization problem, whose solution follows hierarchical steps. The structure of household demand follows a nesting pattern that enables different elasticities of substitution to be used. At the bottom level, substitution occurs across different domestic and imported sources of supply. Utility derived from the

[4] This model is based on the MONASH-MRF Model, which is the latest development in the ORANI suite of CGE models of the Australian economy. The complete specification of the B-MARIA model is available in Haddad and Hewings (1997).

[5] The model is implemented in GEMPACK (Harrison and Pearson, 2002).

consumption of domestic composite goods is maximized. In the subsequent upper level, substitution occurs between domestic composite and imported goods.

One feature presented in SPARTA refers to government demand for public goods. The nature of input-output data enables the isolation of public goods consumption by both the federal and regional governments. However, productive activities carried out by the public sector cannot be isolated from those by the private sector. Thus, government entrepreneurial behavior is dictated by the same cost minimization assumptions adopted by the private sector. This is not a very strong assumption for the Brazilian case because the liberalization policiesof the 1990's offers some enhanced credibility for this assumption. Public good consumption is set to maintain a (constant) proportion with regional private consumption in the case of regional governments, and with national private consumption in the case of the federal government.

Other definitions in the CGE core module include: tax rates, basic and purchase prices of commodities, tax revenues, margins, components of real and nominal GRP/GDP, regional and national price indices, money wage settings, factor prices, and employment aggregates.

Export Demands

Exports faces downward sloping demand curves, indicating that exports are a negative function of their prices in each foreign market: Argentina, Rest of MERCOSUR, NAFTA, Rest of FTAA, European Union, Japan and Rest of the World.

Government Finance Module

The government finances module incorporates equations determining the gross regional product (GRP), expenditure, and factors income for each region, through the breaking down and modeling of its components. The budget deficits of regional governments and the federal government are also determined here. Another important definition in this block of equations refers to the specification of the consumption functions of regional aggregate household. They are defined as a function of household disposable income, which is disaggregated into its main sources of income and the respective tax duties.

Capital Accumulation and Investment Module

Capital stock and investment relationships are defined in this module; however, only the comparative-static version of the model produces reliable results, restricting the use of the model to short-run and long-run policy analysis. When running the model in the comparative-static mode, there is no fixed relationship between capital and investment. The user decides the required relationship on the basis of specific simulation requirements.

Foreign Debt Accumulation Module

This module is based on the specification proposed in ORANI-F (Horridge *et alli.*, 1993) in which a nation's foreign debt is linearly related to accumulated balance-of-trade deficits. In short, trade deficits are financed by increases in the external debt.

Labor Market and Regional Migration Module

In this module, regional population is defined through the interaction of demographic variables, including interregional migration. Links between regional population and regional labor supply are provided. Demographic variables are usually defined exogenously; and together with the specification of some of the labor market settings, labor supply can be determined together with either interregional wage differentials or regional unemployment rates. Shortly, either labor supply and wage differentials determine unemployment rates or labor supply and unemployment rates determine wage differentials.

Closures

SPARTA can be configured to reflect short-run and long-run, comparative-static, and forecasting simulations as well. At this stage, two basic closures for alternative time frames of analysis in single-period simulations are available. A distinction between the two closures relates to the treatment of capital stocks encountered in the standard microeconomic approach to policy adjustments. In the short-run closure, capital stocks are held fixed, while, in the long-run closure, policy changes are allowed to affect capital stocks.

Short-run closure. In addition to the assumption of interindustry and interregional immobility of capital, the short-run closure would include fixed regional population and labor supply, fixed regional wage differentials, and fixed national real wage. Regional employment is driven by the assumptions of wage rates, which indirectly determine regional unemployment rates. These assumptions describe the functioning of the regional labor markets as close as possible to the Brazilian reality. Firstly, changes in the demand for labor are met by changes in the unemployment rate, rather than by changes in the real wage. This seems to be the case in Brazil, given the high level of disguised unemployment in most of the areas in the country; excess supply of labor has been a distinct feature of the Brazilian economy. Secondly, interregional immobility of labor in the short-run suggests that migration is not a short-term decision. Finally, nominal wage differentials in Brazil are persistent, reflecting the geographical segmentation of the workforce (Savedoff, 1990).

On the demand side, investment expenditures are fixed exogenously – firms cannot reevaluate their investment decisions in the short-run. Household consumption follows household disposable income, and government consumption, at both regional and federal levels, is fixed (alternatively, government deficit can be set exogenously, allowing government expenditures to change). Finally, since the model does not present any endogenous-growth-theory-type specification, technology variables are exogenous.

Long-run closure. A long-run (steady-state) equilibrium closure is also available, in which capital and labor are mobile across regions and industries. The main differences from the short-run closure are encountered in the labor market and the capital formation settings. In the first case, aggregate employment is determined by population growth, labor force participation rates, and the natural rate of unemployment. The distribution of labor force across regions and sectors is fully determined endogenously. Labor is attracted to more competitive industries in more favored geographical areas, while, in the same way, capital is oriented towards more attractive industries. This movement keeps the rates of return at their initial levels.

3. SIMULATIONS AND RESULTS

The set of shocks specified for each simulation means either the cheapening of the Brazilian imports coming from the foreign markets or lower prices of the Brazilian exports sent to these markets. From these shocks [6], a simultaneous set of decisions on supply, demand, and investment are affected both sectorially and regionally. The advantage of the CGE model is to treat all these changes in a simultaneous and integrated way. Therefore, the reported results should be viewed as the outcome of general equilibrium relations characterizing a particular specification of the Brazilian economy represented by the SPARTA model.

This paper focus on the regional results of the simulation, specifically the variations at the national and regional levels of activity. First of all, some national macroeconomic results are discussed. Then, the results for the two endogenous regions of the model – Sao Paulo and Other Regions– are presented. Table 2 shows the results for some selected macroeconomic variables in each simulation.

TABLE 2
Selected Long-Run National Results

Simulation	FTAA	EU-MERCOSUR	Other Markets	Full Agreement
Real GDP (% chg.)	0.359	0.347	0.064	0.607
Real Household Consumption (% chg.)	-0.441	-0.389	-0.705	-1.478
Foreign Trade Balance (chg.)*	2.327	1.932	2.897	6.613
Exports (% chg.)	4.290	4.367	4.891	12.538
Imports (% chg.)	0.167	0.855	-0.193	0.781
Real Investment (% chg.)	0.634	0.719	-0.353	0.735
Use of Workforce (% chg.)	0.187	0.185	0.032	0.291
Use of Capital (% chg.)	0.234	0.239	0.190	0.617

* R$ billions, currency as of 1996.

[6] Tables 6 and 7 (**Appendix 2**) show the import tariffs exemptions and export subsidies implemented in each simulation.

The results suggest that the alternative with the highest impact on GDP is a general agreement similar to that to be reached at the closing the Millenium Round negotiations of the World Trade Organization – WTO. The other three simulations may be understood as subsets of such an agreement to the extent that they represent distinct liberalization sets.[7] As for variation and components of GDP, the results are quite similar in the simulations for FTAA and EU-MERCOSUR, and the major difference refers to a higher import expansion in the latter. The simulation for Other Markets has a small impact on the national GDP, although it produces a higher foreign trade balance and a greater expansion of exports. In this case, the small expansion of GDP is connected with a decreased real investment, the only simulation in which this happens.

It is worth understanding such a result in the light of the long-run closure of the model. GDP variations reflect either the expenditure variation or the factors income variation by means of the basic macroeconomic identity. Some components of GDP on the expenditure side and income side must be endogenous so as to satisfy such equality. On the expenditure side, government deficit is exogenous so that taxation on factors income is adjusted in order to hold public deficit (that of federal and regional governments) constant. Liberalization implies a decreased collection of import tariffs and an increased expenditure with export subsidies.

Therefore, tax on factors income are raised so as to restore deficit to the base-year level, which makes household disposable income to decrease, and hence household real consumption (in all simulations). As trade balance response is endogenous and household consumption is linked to government deficit, investment is the component of expenditure which makes GDP variation equal to income variation (gross capital gains and labor earnings). In the simulation for Other Markets, a crowding out effect of trade balance on investment is verified, as household consumption is not sufficient to restore equilibrium. In the remaining simulations, investment must be expanded so as to assure macro equilibrium.

The national results show an expanded use of capital in relation to labor in all simulations, which is due to the long-run closure of the model as national labor supply is fixed (population growth is zero).[8] Such a relative substitution towards capital is more intense in the simulation for other markets, chiefly due to the small expansion in the use of labor. The following analysis of regional and sectoral results better explains such results.

The model enables a detailed observation of domestic inter-regional impacts of the three trade integration alternatives analyzed. The two domestic regions of the model (Sao Paulo and the Other Regions react endogenously to relative price changes in foreign trade specified in each simulation). The previously discussed national results are entirely consistent with regional results, as they represent an aggregation of the latter. The macroregional results in each simulation are shown in Table 3.

[7] If the results for the same variable in the three simulations are added up, a double counting is verified, since both the FTAA simulation and the EU-MERCOSUR simulation include an opening to MERCOSUR.

[8] The use of factors is measured by the variation in its relative income in each simulation.

TABLE 3

Selected Long-Run Macroregional Results

Simulation	FTAA		EU-MERCOSUR		Other Markets		Full Agreement	
Domestic Region	SP	OR	SP	OR	SP	OR	SP	OR
Real GDP (%chg.)	1.232	-0.127	1.259	-0.160	0.051	0.072	1.837	-0.076
Household Real Consumption (%chg.)	0.905	-0.948	0.999	-0.912	-0.523	-0.774	0.587	-2.257
Foreign Trade Balance (chg.)*	0.616	1.657	0.419	1.500	0.929	1.934	1.962	4.696
Exports (%chg.)	4.605	4.113	4.598	4.236	3.757	5.529	11.813	12.946
Imports (%chg.)	1.575	-0.379	2.528	0.088	-0.791	0.169	2.187	0.009
Domestic Trade Balance (chg.)*	-2.780	2.780	-2.718	2.718	-1.524	1.524	-5.433	5.433
Real Investment (%chg.)	4.497	-1.023	4.923	-1.084	-1.396	0.090	5.200	-1.181
Capital Stock (%chg.)	0.570	0.077	0.613	0.065	0.000	0.278	0.870	0.499
Employment (%chg.)	1.472	-0.409	1.456	-0.404	0.250	-0.069	2.321	-0.644

SP: Sao Paulo, OR: Other Regions in Brazil.
*R$ billions, currency as of 1996.

The domestic impacts presented in Table 3 suggest that the Sao Paulo economy tends to be relatively benefited specially in the case of a full agreement. In the Other Markets simulation only, Other Regions of Brazil show a relative gain in terms of GDP variation. Such a result seems to be influenced mainly by the foreign trade balance which shows a higher expansion in this simulation as compared to variations in the case of FTAA simulation and EU-MERCOSUR simulation. It is worth noting that the simulation for Other Markets is that with the smallest impact on domestic trade flows (R$ 1.524 billion), though it shows the highest impact on foreign trade balance (R$ 2.897 billion).

The domestic interregional trade behavior illustrates important features in the Brazilian economic space interrelations. We may cite two important components in the determination of interregional trade impact: the substitution effect and the activity effect. The rise (fall) of the regional activity level implies a greater (smaller) need for domestic imports; the fall (rise) of the relative price of domestic imports (vis-à-vis exports) bears deficit (surplus) through the substitution effect.[9] What can be observed in the simulations is that the Sao Paulo economy has its domestic trade balance marginally decreased (and, by definition, the other regions of Brazil have their domestic trade balance marginally increased).[10] Therefore, the rise in the activity level of the Sao Paulo economy in all simulations bears an increase in its requirements for domestic imports, an effect reinforced by the decrease in the relative prices of these imports. The results generally indicate that the domestic trade balance acts, in the other regions in Brazil, as a buffer against the decrease of the activity level, as has

[9] The variations (%) in the domestic trade balance, *s*, are estimated as *s* = (*XSEXP**(*psexp*-*xsexp*) - *XSIMP**(*pimp*-*xsimp*), where *psexp* is the variation (%) of export prices, *xsexp* is the variation (%) of export amount, and *pimp* and *xsimp* are their counterparts on the imports side. *XSEXP* and *XSIMP* represent the values of regional exports and imports, respectively.

[10] Changes are marginal, as they do not represent changes in the surplus position of the São Paulo economy and deficit position of the other regions in interregional trade.

been observed in the simulations for FTAA and EU-MERCOSUR. It is worth mentioning that, even in the case that this domestic region is relatively benefited (Other Markets simulation), the activity effect of the Sao Paulo economy prevails in such a way that the domestic trade balance benefits the other regions in Brazil.[11]

In the simulations for trade opening, regional and sectoral investment is affected by changes in the rates of capital return in the base year. The impact on the rate of return occurs through two channels: the production cost of capital goods and the price of capital. Given the share of imports on the composition of capital goods, *ceteris paribus*, decreased tariffs tend to raise the rate of return on capital for most sectors. Investments (capital formation) are directed to those sectors more benefited by the opening, as the expansion in the activity level requires additional capital units. Furthermore, increased capital stock in the economy depresses the price of additional capital units. Movements by such components change the rate of return on capital in each regional sector as well as the average rate of return on capital in the region. The formation of sectoral capital is oriented in such a way as to restore differentials of capital return in each domestic region.

The results of simulations suggest that capital formation (investment) is directed to Sao Paulo in the simulations for FTAA and EU-MERCOSUR and for Other Regions in Brazil in the simulation for Other Markets.[12] The decreased real investment in Other Regions in Brazil in the simulations for FTAA and EU-MERCOSUR indicates that the effect of decreased duties on imports has a less important impact on the cost of generation of capital goods in the region due to decreased imports (Domingues, 2002). A full agreement would represent a shift of capital for the São Paulo economy. Such results are closely related to a series of sectors more/less benefited in each simulation as seen below.

The projections of interregional shift of employment suggest migration to the Sao Paulo economy in all simulations even in the alternative of Other Markets, in which the expansion of the activity level in the Sao Paulo economy is smaller than the expansion in the Other Regions in Brazil. That is, in this simulation, the expansion of the activity level in the Other in Brazil occurs with the decreased employment level and increased capital-labor ratio (in São Paulo, employment rises and capital-labor relation decreases). The projections of interregional employment shifts point to migration into the Sao Paulo economy in all simulations even in the alternative Other Markets in which expansion of the activity level of the Sao Paulo economy is smaller than the expansion in the Other Regions in Brazil. That is to say, in this simulation, expansion in the activity level in the Other Regions in Brazil occurs with a decreasing employment level and increasing capital-labor ratio (in Sao Paulo, employment rises and capital-labor relation diminishes).[13]

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[11] The sectoral results – discussed in the next section – suggest that the major affected sectors in this simulation are those exporting products showing low linkages in the domestic economy (e.g., via purchase of inputs) in such a way that the effect on the domestic trade is relatively small. However, the expansion of the activity level in the São Paulo economy shows a significant impact on the domestic interregional trade according to the results of the simulations.

[12] The result of the level of national investment decreased only in the simulation for Other Markets (see Table 3). Thus, the shift of investment for the Other Regions in Brazil in this simulation occurs in a scenario of decreased aggregate investment.

[13] The model adopts price-elasticity of substitution between capital and labor equal to 0.5 in all sectors.

A better understanding of these effects requires a more detailed observation of sectoral relations in the simulations. Table 4 presents projections of the sectoral activity level in Sao Paulo for each simulation. Table 5, in turn, shows projections of sectoral activity level in the Other Regions in Brazil. The sectoral activity variations also represent the direction towards which the sectoral employment variation moves.

The sectoral results may be partially understood as moving towards the sectors' foreign trade. It should be highlighted, however, that the projected result for the activity level of the sector depends not only on the cutoff of tariffs in each simulation and the sectoral trade flow as well, but mainly on the economic interrelations (general equilibrium) captured by the model. However, a qualitative analysis of results may be accomplished based on the comparison between more/less benefited sectors in each simulation and the destination of foreign trade in the sector during the base year. The sectoral trade destination is an indicator – sector by sector – of direct export gains and losses with the increased competition with imports.

An analysis of some sectors will be presented below in order to illustrate such relations. It is worth remembering that the observed result of the sectoral activity level is the outcome not only of trade destination and tariffs in each simulation, but also of sectoral interrelations, linkage effects and spillovers, supply constraints, and other factors captured by the general equilibrium model. Table 4 shows the sectoral result in Sao Paulo for each simulation. Table 8 (**Appendix 2**) presents the trade destination in this state in the base year. Let us take the simulation for FTAA into account. The most benefited sectors are: Textiles, Processed Vegetables, and Machinery. Textiles represent 2.18% of the state exports and 75.44% of these exports are destined for the FTAA markets. Textiles represent 2.87% of imports and 47.42% come from the FTAA. The result of tariff exemption of the sector in simulation for FTAA, in principle, tend to represent an increment of its activity level in Sao Paulo. As compared to the small expansion of textiles in the simulation for Other Markets, such a result may be related to the situation of foreign trade in this case, among other factors, since 32.28% of textile imports come from these markets and only 16.05% of exports are destined for them.

The Machinery sector has a widely recognized representativiness in the Sao Paulo exports to the FTAA markets. As can be seen from Table 8 (**Appendix 2**), the FTAA markets are the destination of 7.45% of the state exports of such products, while 18.33% are sent to the EU. This sector also shows a relevant share in imports (8.73% of total imports), which are distributed between FTAA (37.99%) and the EU (48.22%). This partially explains the strong expansion of its level of activity in the simulations for FTAA and EU-MERCOSUR and the more attenuated expansion in the simulation for Other Markets.

Projections for the Sao Paulo sector of Electronic Equipment illustrate how important is taking account of general equilibrium effects in the analysis of economic integration and not only of sectoral indicators of foreign trade. This is the sector with the greatest share in Sao Paulo imports (13.56% of total imports), distributed between the FTAA (39.51%), the EU (36.34%), and Other Markets (24.15%). On the other hand, exports of the sector represent only 3.47% of the total and are mainly destined for the FTAA (69.78%), Other Markets (15.60%), and the EU (14.62%). This sector accounts for a significant deficit in the Brazilian trade balance. Such indicators would lead us to expect a negative impact on the activity level of this sector due to trade opening, given the significant imports, less expressive exports, and the relatively high tariffs in the Brazilian market. However, the SPARTA model projects a positive result for the Sao Paulo segment of this sector in the simulations for the FTAA and EU-MERCOSUR. Such a result is an example of the range of general equilibrium effects: the direct impact of the opening was offset by the indirect effects, just as the increased economic activity in Sao Paulo, enhancement of investment, and demand for inputs from the other sectors of the economy. In the simulation for Other Markets, where the activity effect of the Sao Paulo (and national) economy is relatively smaller, the higher competition with imports gives rise to a negative result for the variation of the activity level in the sector.

Table 5 presents the projected results of the activity level for the sectors of the Other Regions in Brazil in the simulations. The simulation for Other Markets is, notably, the one benefiting a greater set of sectors and presenting cases of significant gains, as for example, Mining, Vegetal Oil Meals, Meat Packing Plants, and Steel. This is an expected result due to four distinct factors: 1) the high share of such exports from the Other Regions in Brazil, about 21.0% of total exports (Table 9 of **Appendix 2**); 2) the major destination of such exports for Other Markets; 3) a significant tax exemption in this simulation (Table 9 of **Appendix 2**); and 4) less significant imports of such products.[14]

Projections for the sector of Electronic Equipment of the Other Regions in Brazil, showing decreased activity level in all simulations, is just the opposite. Similarly to the Sao Paulo segment of this sector, it accounts for an important proportion of imports of the region (11.71% of the total) and a small proportion of exports (0.89% of total exports). Imports of such goods come from the FTAA (34.63%), EU (29.05%), and Other Markets (36.33%). Therefore, the widened competition with imports seems to be a major cause of the negative result for the sector which is reinforced by the decreased activity level in the region (in the simulations for the FTAA and EU-MERCOSUR)[15]

Sectoral results help us understand why the simulation for Other Regions in Brazil has projected a result that relatively benefits the other regions in Brazil and not Sao Paulo, differently from the simulations for the FTAA and EU-MERCOSUR. In the simulation for Other Markets, the major products directly affected by tariff liberalization are quite representative of the exports of this region, and competition with imports is negligible. Additionally, the share of these sectors in regional production is very high.[16]

The projected decrease in employment in Other Regions in the simulation for Other Markets – even with the rise in the activity level in the region – means net migration to Sao Paulo and is related to the cost structure of the most benefited sectors. If three out of these sectors are accounted for (Petroleum Refining, Chemicals, and Other Chemicals, Steel, and Vegetable Oil Meals, capital-labor relations well above the average can be observed.[17] Therefore, the output expansion in these sectors requires a more significant rise of capital in relation to labor in the region, and hence the increase in investment and fall in labor verified in this simulation (Table 3). The national results show that a greater relative expansion in the use of capital in relation to the use of labor can be observed in the simulation for Other Markets.

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[14] These products are the main source of foreign trade surplus in the region – 0.60% of regional GDP.

[15] This sector's trade shows the highest foreign trade deficit in the region – 0.90% of regional GDP.

[16] The 5 sectors with the highest expansion of activity level account for 14.2% of production in the simulation for Other Regions in Brazil.

[17] The average capital-labor relation in Other Regions of Brazil is 1.20, and these sectors show capital-labor relations of 8.00, 8.21, and 5.34, respectively (Domingues, 2002, Table 3.3).

TABLE 4

SPARTA Projected Long-Run Percentage Effects of Alternative Trade Strategies: Sao Paulo, activity by industry

	Sector	FTAA	EU-Mercosur	Other Markets	Full Agreement
S1	Agriculture	0.790	0.990	0.880	2.580
S2	Mining	1.730	1.660	2.330	4.940
S3	Oil and gas	0.580	0.700	0.250	1.550
S4	Nonmetallic Minerals	1.260	1.310	0.030	1.890
S5	Steel	1.690	1.380	1.410	3.770
S6	Nonferrous Metals	1.350	1.470	1.280	3.340
S7	Other Metal Products	1.170	1.100	0.340	1.950
S8	Machinery	1.810	1.690	0.790	3.380
S9	Electrical Equipment	0.530	0.530	-0.070	0.670
S10	Electronic Equipment	1.000	1.060	-0.120	1.290
S11	Automobile Industry	0.910	0.900	-0.440	0.610
S12	Other Vehicles and Parts	0.860	0.890	0.720	2.000
S13	Wood Products and Furniture	0.680	0.720	-0.330	0.490
S14	Paper Products and Printing	0.620	0.600	0.370	1.240
S15	Rubber	0.950	0.780	0.460	1.790
S16	Chemicals	0.820	0.890	0.500	1.620
S17	Petroleum Refining	1.120	0.570	1.660	3.110
S18	Other Chemicals	1.050	1.110	0.690	2.360
S19	Pharmaceutical and Veterinary	0.710	0.640	-0.180	0.680
S20	Plastics	0.760	0.790	0.350	1.480
S21	Textiles	2.170	1.790	0.170	3.290
S22	Clothing	0.370	0.580	-0.970	-0.460
S23	Footwear	0.130	-0.210	-0.330	0.710
S24	Coffee	1.110	0.870	0.740	2.320
S25	Processed Vegetables	1.990	1.930	1.010	3.650
S26	Meat Packing Plants	0.770	2.590	1.320	4.350
S27	Dairy Products	-0.390	-0.410	0.570	0.410
S28	Sugar	0.620	0.170	1.280	1.970
S29	Vegetable Oil Meals	0.650	0.660	1.200	2.320
S30	Beverages and Other Food Products	0.670	0.590	0.620	1.550
S31	Other Manufacturing	0.700	0.750	-0.200	1.020

TABLE 5

SPARTA Projected Long-Run Percentage Effects of Alternative Trade Strategies: Other Regions in Brazil, activity by industry

	Sector	FTAA	EU-Mercosur	Other Markets	Full Agreement
S1	Agriculture	0.690	0.840	1.190	2.740
S2	Mining	2.130	1.950	5.070	8.240
S3	Oil and gas	0.080	0.190	0.280	0.920
S4	Nonmetallic Minerals	0.550	0.570	0.160	1.040
S5	Steel	1.590	1.190	1.560	3.680
S6	Nonferrous Metals	0.800	0.940	1.220	2.520
S7	Other Metal Products	0.580	0.380	0.600	1.290
S8	Machinery	0.150	0.010	0.660	0.880
S9	Electrical Equipment	0.010	0.000	0.200	0.300
S10	Electronic Equipment	-0.710	-0.680	-0.290	-1.310
S11	Automobile Industry	-0.230	-0.420	-0.010	-0.410
S12	Other Vehicles and Parts	0.290	0.250	1.230	1.720
S13	Wood Products and Furniture	0.010	0.060	0.040	0.110
S14	Paper Products and Printing	0.210	0.250	0.530	0.920
S15	Rubber	0.310	0.150	0.230	0.650
S16	Chemicals	0.310	0.340	0.480	0.880
S17	Petroleum Refining	1.110	0.580	1.860	3.270
S18	Other Chemicals	0.760	0.860	0.830	2.140
S19	Pharmaceutical and Veterinary	-0.430	-0.480	-0.180	-0.910
S20	Plastics	0.150	0.160	0.410	0.660
S21	Textiles	1.660	1.300	-0.100	2.310
S22	Clothing	-1.120	-0.950	-1.330	-2.980
S23	Footwear	1.140	-0.070	0.210	2.350
S24	Coffee	-0.100	-0.170	0.180	0.010
S25	Processed Vegetables	0.050	0.070	0.350	0.340
S26	Meat Packing Plants	-0.250	0.710	2.120	2.810
S27	Dairy Products	-1.070	-0.960	0.220	-0.800
S28	Sugar	1.100	-0.180	1.020	2.090
S29	Vegetable Oil Meals	0.610	0.450	3.040	3.840
S30	Beverages and Other Food Products	-0.780	-0.980	0.080	-1.330
S31	Other Manufacturing	-0.080	-0.030	-0.170	0.030

4. FINAL REMARKS

The results have shown that interregional trade plays an important role as a transmission mechanism. This points out that interregional feedback should not be neglected in order to have a better understanding of how regional economies are affected, both in the domestic and foreign markets. For example, in the Brazilian less developed regions, the performance of more developed states play a crucial role, probably more important than the dynamics of foreign trade, as the results show for the Other Regions which benefit mainly from Sao Paulo's inter-regional demand.

Finally, as a methodological note, the SPARTA model, proposed and implemented here, has proved worthwhile. Despite its requirement of a extensive amount of data, it has produced consistent results, which provided interesting insights into regional inequality in a federative system. A more detailed regional specification, which would include all Brazilian states, still remains the best framework, but data availability to date have precluded this alternative.

Appendix 1[18]

The functional forms of the main groups of equations of the SPARTA CGE core are presented in this Appendix together with the definition of the main groups of variables, parameters, and coefficients.

The notational convention uses uppercase letters to represent the levels of the variables and lowercase for their percentage-change representation. Superscripts *(u)*, *u = 0, 1j, 2j, 3, 4, 5, 6*, refer, respectively, to output *(0)* and to the six different regional-specific users of the products identified in the model: producers in sector *j (1j)*, investors in sector *j (2j)*, households *(3)*, purchasers of exports *(4)*, regional governments *(5)*, and the federal government *(6)*; the second superscript identifies the domestic region where the user is located. Inputs are identified by two subscripts: the first takes the values *1, ..., g*, for commodities, *g + 1*, for primary factors, and *g + 2*, for "other costs" (basically, taxes and subsidies on production); the second subscript identifies the source of the input, being it from domestic region *b (1b)* or from foreign market *f (2f)*, or coming from labor *(1)*, capital *(2)* or land *(3)*. The symbol (•) is employed to indicate a sum over an index.

Equations

(A1) Substitution between products from different regional domestic sources

$$x_{(i(1b))}^{(u)r} = x_{(i(1\bullet))}^{(u)r} - \sigma_{(i)}^{(u)r}\left(p_{(i(1b))}^{(u)r} - \sum_{l \in S} \left(V(i,1l,(u),r) / V(i,1\bullet,(u),r)\right)\left(p_{(i(1l))}^{(u)r}\right)\right)$$

$i = 1,...,g;\ b = 1,...,q;\ (u) = 3$ and (kj) for $k = 1$ and 2 and $j = 1,...,h;\ r = 1,...,R$

[18] Thanks to Eduardo A. Haddad for providing the basis for this Appendix.

(A1) Substitution between products from different imported sources

$$x^{(u)r}_{(i(2f))} = x^{(u)r}_{(i(2\bullet))} - \sigma^{(u)r}_{(i)}\,(p^{(u)r}_{(i(2f))} - \sum_{l\in F}(V(i,2l,(u),r)/V(i,2\bullet,(u),r)(p^{(u)r}_{(i(2l))}))$$

$i = 1,..., g;\; f = 1,..., F;\; (u) = 3$ and (kj) for $k = 1$ and 2 and $j = 1,..., h; r = 1,..., R$

(A2) Substitution between domestic and imported products

$$x^{(u)r}_{(is)} = x^{(u)r}_{(i\bullet)} - \sigma^{(u)r}_{(i)}\,(p^{(u)r}_{(is)} - \sum_{l=1\bullet,2\bullet}(V(i,l,(u),r)/V(i,\bullet,(u),r)(p^{(u)r}_{(il)}))$$

$i = 1,..., g;\; s = 1\bullet$ and $2\bullet$; $(u) = 3$ and (kj) for $k = 1$ e 2 and $j = 1,..., h; r = 1,..., R$

(A3) Substitution between labor, capital and land

$$x^{(1j)r}_{(g+1,s)} - a^{(1j)r}_{(g+1,s)} = \alpha^{(1j)r}_{(g+1,s)} x^{(1j)r}_{(g+1\bullet)} - \sigma^{(1j)r}_{(g+1)}\{p^{(1j)r}_{(g+1,s)} + a^{(1j)r}_{(g+1,s)}$$
$$- \sum_{l=1,2,3}(V(g+1,l,(1j),r)/V(g+1,\bullet,(1j),r))(p^{(1j)r}_{(g+1,l)} + a^{(1j)r}_{(g+1,l)})\}$$

$j = 1,..., h;\quad s = 1, 2$ and $3; r = 1,..., R$

(A4) Intermediate and investment demands for composite commodities and primary factors

$$x^{(u)r}_{(i\bullet)} = \mu^{(u)r}_{(i\bullet)} z^{(u)r} + a^{(u)r}_{(i)}$$

$u = (kj)$ for $k = 1, 2$ and $j = 1,..., h$
if $u = (1j)$ then $i = 1,...,g+2$
if $u = (2j)$ then $i = 1,...,g;$
$r = 1,..., R$

(A5) Household demands for composite commodities

$$V(i,\bullet,(3),r)(p^{(3)r}_{(i\bullet)} + x^{(3)r}_{(i\bullet)}) =$$
$$\gamma^{r}_{(i)} P^{(3)r}_{(i\bullet)} Q^{r}(p^{(3)r}_{(i\bullet)} + x^{(3)r}_{(i\bullet)}) + \beta^{r}_{(i)}(C^{r} - \sum_{j\in G}\gamma^{r}_{(j)} P^{(3)r}_{(i\bullet)} Q^{r}(p^{(3)r}_{(i\bullet)} + x^{(3)r}_{(i\bullet)}))$$

$i = 1, \ldots, g; r = 1,..., R$

(A6) Composition of output by industries

$$x_{(i1)}^{(0j)r} = z^{(1j)r} + \sigma^{(0j)r}(p_{(i1)}^{(0)r} - \sum_{t\in G}(Y(t,j,r)/Y(\bullet,j,r))\,p_{(t1)}^{(0)r})$$

$j = 1,...,h;\;\; \mathrm{i} = 1,...,\mathrm{g};\; r = 1,...,R$

(A7) Indirect tax rates

$$t(\tau,i,s,(u)r) = f_{(\tau)} + f_{(\tau i)} + f_{(\tau i)}^{(u)} + f_{(\tau i)}^{(u)r}, \quad i = 1,...,g;\;\; s = 1b, 2f \text{ for } b = 1,...,q \text{ and } f = 1,...,F;$$

$\tau = 1,...,t;\; (u) = (3),(4),(5),(6)$ and

(kj) for $k = 1, 2$ and $j = 1,...,h; r = 1,...,R$

(A8) Purchasers' prices related to basic prices, margins (transportation costs) and taxes

$$V(i,s,(u),r)\,p_{(is)}^{(u)r} = (B(i,s,(u),r) + \sum_{\tau\in T} T(\tau,i,s,(u),r))(p_{(is)}^{(0)} + t(\tau,i,s,u,r))$$

$$+ \sum_{m\in G} M(m,i,s,(u),r)p_{(m1)}^{(0)r},$$

$i = 1,...,g;\; (u) = (3),(4),(5),(6)$

and (kj) for $k = 1, 2$ and $j = 1,...,h; s = 1b, 2f$ for $b = 1,...,q$ and $f = 1,...,F$

$r = 1,...,R$

(A9) Foreign demands (exports) for domestic goods

$$(x_{(is)}^{(4f)r} - fq_{(is)}^{(4f)r}) = \eta_{(is)}^{r}(p_{(is)}^{(4f)r} - e - fp_{(is)}^{(4f)r}), \quad i = 1,...,g;\; s = 1b, 2\mathrm{f} \text{ for } b = 1,...,q \text{ and}$$

$f = 1,...,F; r = 1,...,R;$

(A10) Regional governments demands

$$x_{(is)}^{(5)r} = x_{(\bullet\bullet)}^{(3)r} + f_{(is)}^{(5)r} + f^{(5)r} + f^{(5)} \quad i = 1,...,g;\; s = 1b, 2f \text{ for } b = 1,...,q; \mathrm{r} = 1,...,\mathrm{R}$$

$f = 1,...,F$

(A11) Regional governments demands

$$x_{(is)}^{(6)r} = x_{(\bullet\bullet)}^{(3)\bullet} + f_{(is)}^{(6)r} + f^{(6)r} + f^{(6)} \quad i = 1,...,g;\; s = 1b, 2f \text{ for } b = 1,...,q \text{ and } f = 1,...,F; \mathrm{r} = 1,...,\mathrm{R}$$

(A12) Margin demands for domestic goods

$$x^{(is)(u)r}_{(m1)} = \theta^{(u)r}_{(is)} x^{(u)r}_{(is)} + a^{(is)(u)r}_{(m1)}$$

$m, i = 1, \ldots, g;$
$(u) = (3), (4b)$ for $b = 1, \ldots, r$, (5) and (kj) for $k = 1, 2;$
$j = 1, \ldots, h;\ s = 1b, 2f$ for $b = 1, \ldots, q$ and $f = 1, \ldots, F$
$r = 1, \ldots, R;$

(A13) Demand equals supply for regional domestic commodities

$$\sum_{j \in H} Y(l, j, r) x^{(0j)r}_{(l1)} = \sum_{u \in U} B(l, 1, (u), r) x^{(u)r}_{(l1)} + \sum_{i \in G} \sum_{s \in S} \sum_{u \in U} M(l, i, s, (u), r) x^{(is)(u)r}_{(l1)} \qquad l = 1, \ldots, g;\ r = 1, \ldots, R$$

(A14) Regional industry revenue equals industry costs

$$\sum_{l \in G} Y(l, j, r)(p^{(0)r}_{(l1)} + a^{(0)r}_{(l1)}) = \sum_{l \in G^*} \sum_{s \in S} V(l, s, (1j), r)(p^{(1j)r}_{(ls)}), \quad j = 1, \ldots, h;\ r = 1, \ldots, R$$

(A15) Basic price of imported commodities

$$p^{(0)}_{(i(2f))} = p^{(w)}_{(i(2f))} - e + t^{(0)}_{(i(2f))}, \qquad i = 1, \ldots, g;\ f = 1, \ldots, F$$

(A16) Cost of constructing units of capital for regional industries

$$V(\bullet, \bullet, (2j), r)(p^{(1j)r}_{(k)} - a^{(1j)r}_{(k)}) = \sum_{i \in G} \sum_{s \in S} V(i, s, (2j), r)(p^{(2j)r}_{(is)} + a^{(2j)r}_{(is)}), \quad j = 1, \ldots, h;\ r = 1, \ldots, R$$

(A17) Investment behavior

$$z^{(2j)r} = x^{(1j)r}_{(g+1,2)} + 100 f^{(2j)r}_{(k)}, \qquad j = 1, \ldots, h;\ r = 1, \ldots, R$$

(A18) Capital stock in period T+1 – comparative static

$$x^{(1j)r}_{(g+1,2)}(1) = x^{(1j)r}_{(g+1,2)} \qquad j = 1, \ldots, h;\ r = 1, \ldots, R$$

(A19) Definition of rates of return on capital

$$r^{r}_{(j)} = Q^{r}_{(j)}(p^{(1j)r}_{(g+1,2)} - p^{(1j)r}_{(k)}), \qquad j = 1,...,h; r = 1,...,R$$

(A20) Relation between capital growth and rates of return

$$r^{r}_{(j)} - \omega = \varepsilon^{r}_{(j)}(x^{(1j)r}_{(g+1,2)} - x^{(\bullet)r}_{(g+1,2)}) + f^{r}_{(k)}, \qquad j = 1,...,h; r = 1,...,R$$

Other definitions in the CGE core include: revenue from indirect taxes, import volume of commodities, components of regional/national GDP, regional/national price indices, wage settings, definitions of factor prices, and employment aggregates.

Variables

Variable	Index ranges	Description

$x_{(is)}^{(u)r}$	(u) = (3), (4), (5), (6) and
	(kj) for k = 1, 2 and j = 1,…,h;
	if (u) = (1j) then i = 1,…,g + 2;
	if (u) ≠ (1j) then i = 1,…,g;
	s = 1b, 2f for b = 1,…,q; f = 1,…,F;
	and i = 1,…,g and
	s = 1, 2, 3 for i = g+1
	r = 1,…,R
		Demand by user (u) in region r for good or primary factor (is)

$p_{(is)}^{(u)r}$	(u) = (3), (4), (5), (6) and
	(kj) for k = 1, 2 and j = 1,…,h;
	if (u) = (1j) then i = 1,…,g + 2;
	if (u) ≠ (1j) then i = 1,…,g;
	s = 1b, 2f for b = 1,…,q; f = 1,…,F;
	and i = 1,…,g and
	s = 1, 2, 3 for i = g+1
	r = 1,…,R
		Price paid by user (u) in region r for good or primary factor (is)

$x_{(i\bullet)}^{(u)r}$	(u) = (3) and (kj) for k = 1, 2 and
	j = 1, …,h.
	if (u) = (1j) then i = 1, …,g + 1;
	if (u) ≠ (1j) then i = 1, …,g
	r = 1,…,R
		Demand for composite good or primary factor i by user (u) in region r

$a_{(g+1,s)}^{(1j)r}$	j = 1, …,h and s = 1, 2, 3 r = 1,…,R	Primary factor saving technological change in region r
$a_{(i)}^{(u)r}$	i = 1,...,g, (u) = (3) and (kj) for k = 1, 2 and j = 1,..., h r = 1,…,R	Technical change related to the use of good i by user (u) in region r
C^r		Total expenditure by regional household in region r
Q^r		Number of households
$z^{(u)r}$	(u) = (kj) for k = 1, 2 and j = 1, …,h r = 1,…,R	Activity levels: current production and investment by industry in region r
$fq_{(is)}^{(4)r}$	i = 1, …,g; s = 1b, 2f for b = 1, …,q; f = 1,…,F; r = 1,…,R	Shift (quantity) in foreign demand curves for regional exports
$fp_{(is)}^{(4)r}$	i = 1, …,g; s = 1b, 2f for b = 1, …,q; f = 1,…,F; r = 1,…,R	Shift (price) in foreign demand curves for regional exports
e		Exchange rate
$x_{(m1)}^{(is)(u)r}$	m, i = 1,…,g; s = 1b, 2f for b = 1,…,q; f = 1,…,F; (u) = (3), (4), (5), (6) and (kj) for k = 1, 2 and j = 1, …,h r = 1,…,R	Demand for commodity (m1) to be used as a margin to facilitate the flow of (is) to (u) in region r
$a_{(m1)}^{(is)(u)r}$	m, i = 1,…,g; s = 1b, 2f; for b = 1,…,q; f = 1,…,F; (u) = (3), (4), (5), (6) and (kj) for k = 1, 2 and j = 1, …,h r = 1,…,R	Technical change related to the demand for commodity (m1) to be used as a margin to facilitate the flow of (is) to (u) in region r

Variable	Index ranges	Description
$x_{(i1)}^{(0j)r}$	i = 1,…,g; j = 1,…,h r = 1,...,R	Output of domestic good i by industry j
$p_{(is)}^{(0)r}$	i = 1,…,g; s = 1b, 2f for b = 1,…,q; f = 1,…,F; r = 1,...,R	Basic price of good i in region r from source s
$p_{(i(2))}^{(w)}$	i = 1,…,g	USD c.i.f. price of imported commodity i
$t_{(i(2))}^{(0)}$	i = 1,…,g	Power of the tariff on imports of i
$t(\tau,i,s,(u)r)$	i = 1,…,g; τ = 1,…,t; s = 1b, 2f for b = 1,…,q; f = 1,…,F (u) = (3), (4), (5), (6) and (kj) for k = 1, 2 and j = 1,…,h r = 1,...,R	Power of the tax τ on sales of commodity (is) to user (u) in region r
$f_{(k)}^{(2j)r}$	j = 1,…,h r = 1,...,R	Regional-industry-specific capital shift terms
$f_{(k)}^{r}$	r = 1,...,R	Capital shift term in region r
$x_{(g+1,2)}^{(1j)r}(1)$	j = 1,…, h r = 1,...,R	Capital stock in industry j in region r at the end of the year, i.e., capital stock available for use in the next year
$p_{(k)}^{(1j)r}$	j = 1,…, h r = 1,...,R	Cost of constructing a unit of capital for industry j in region r
$f_{(\tau)}$	τ = 1,…,t	Shift term allowing uniform percentage changes in the power of tax τ
$f_{(\tau i)}$	τ = 1,…,t; i = 1, …,g	Shift term allowing uniform percentage changes in the power of tax τ on commodity i
$f_{(\tau i)}^{(u)}$	τ = 1,…,t; (u) = (3), (4), (5), (6) and (kj) for k = 1, 2 and j = 1, …, h	Shift term allowing uniform percentage changes in the power of tax τ of commodity i on user (u)
$f_{(\tau i)}^{(u)r}$	τ = 1,…,t; (u) = (3), (4), (5), (6) and (kj) for k = 1, 2 and j = 1, …, h r = 1,…,R	Shift term allowing uniform percentage changes in the power of tax τ of commodity i on user (u) in region r
$f_{(is)}^{(5)r}$	i = 1, …,g; s = 1b, 2f for b = 1,…,q; f = 1,…,F; r = 1,…,R	Commodity and source-specific shift term for regional government expenditures in region r
$f^{(5)r}$	r = 1,…,R	Shift term for regional government expenditures in region r
$f^{(5)}$		Shift term for regional government expenditures
$f_{(is)}^{(6)r}$	i = 1, …,g; s = 1b, 2f for b = 1,…,q; f = 1,…,F; r = 1,…,R	Commodity and source-specific shift term for federal government expenditures in region r
$f^{(6)r}$	r = 1,…,R	Shift term for federal government expenditures in region r
$f^{(6)}$		Shift term for federal government expenditures
ω		Overall rate of return on capital (short-run)
$r_{(j)}^{r}$	j = 1,...,h r = 1,…,R	Regional-industry-specific rate of return

Parameters, Coefficients and Sets

Symbol	Description
$\sigma_{(i)}^{(u)r}$	Parameter: elasticity of substitution between alternative sources of commodity or factor i for user (u) in region r
$\sigma^{(0j)r}$	Parameter: elasticity of transformation between outputs of different commodities in industry j in region r
$\alpha_{(g+1,s)}^{(1j)r}$	Parameter: returns to scale to individual primary factors in industry j in region r
$\beta_{(i)}^{r}$	Parameter: marginal budget shares in linear expenditure system for commodity i in region r
$\gamma_{(i)}^{r}$	Parameter: subsistence parameter in linear expenditure system for commodity i in region r
$\varepsilon_{(j)}^{r}$	Parameter: sensitivity of capital growth to rates of return of industry j in region r
$\eta_{(is)}^{r}$	Parameter: foreign elasticity of demand for commodity i from region r
$\theta_{(is)}^{(u)r}$	Parameter: scale economies to transportation of commodity (i) produced in region r shipped to user (u) in region r
$\mu_{(i\bullet)}^{(u)r}$	Parameter: returns to scale to primary factors (i = g+1 and u = 1j); otherwise, $\mu_{(i\bullet)}^{(u)r} = 1$
$B(i,s,(u),r)$	Input-output flow: basic value of (is) used by (u) in region r
$M(m,i,s,(u),r)$	Input-output flow: basic value of domestic good m used as a margin to facilitate the flow of (is) to (u) in region r
$T(\tau,i,s,(u),r)$	Input-output flow: collection of tax τ on the sale of (is) to (u) in region r
$V(i,s,(u),r)$	Input-output flow: purchasers' value of good or factor i from source s used by user (u) in region r
$Y(i,j,r)$	Input-output flow: basic value of output of domestic good i by industry j from region r
$Q_{(j)}^{r}$	Coefficient: ratio, gross to net rate of return
G	Set: {1,2, …, g}, g is the number of composite goods
G*	Set: {1,2, …, g+1}, g+1 is the number of composite goods and primary factors
H	Set: {1,2, …, h}, h is the number of industries
U	Set: {(3), (4), (5), (6), (k j) for k = 1, 2 and j = 1, …, h}
U*	Set: {(3), (k j) for k = 1, 2 and j = 1, …, h}
S	Set: {1, 2, …, r+1}, r+1 is the number of regions (including foreign)
S*	Set: {1, 2, …,r}, r is the number of domestic regions
F	Set: {1, 2, …,F}, F is the number of foreign regions
T	Set: {1, …, t}, t is the number of indirect taxes

Appendix 2

TABLE 6

Import tariffs in Brazil, by source, 1996 (% ad-valorem)

		Argentina	Other Mercosur	Nafta	Other FTAA	EU	Japan	ROW	Mean
S1	Agriculture	4.295	4.342	3.703	4.364	3.445	1.006	4.263	4.143
S2	Mining	1.503	30.993	0.131	1.169	2.769	0.000	2.037	1.399
S3	Oil and gas	11.476	2.040	2.040	11.397	7.249	0.000	9.181	8.559
S4	Nonmetallic Minerals	6.729	6.093	6.652	5.893	6.096	6.151	8.704	6.774
S5	Steel	5.246	4.639	5.507	4.233	5.411	5.891	5.354	5.420
S6	Nonferrous Metals	6.724	4.237	4.874	4.465	5.403	6.623	4.530	4.904
S7	Other Metal Products	9.030	7.430	8.784	8.008	9.483	9.363	8.797	9.230
S8	Machinery	6.725	7.021	6.607	6.882	6.969	6.101	6.769	6.750
S9	Electrical Equipment	9.680	10.107	9.511	9.907	10.032	8.782	9.744	9.590
S10	Electronic Equipment	8.310	7.535	5.959	6.909	5.464	5.607	5.699	5.721
S11	Automobile Industry	20.895	25.935	22.616	25.018	19.925	22.805	24.502	21.036
S12	Other Vehicles and Parts	9.018	9.061	3.558	13.654	7.875	10.420	9.003	5.030
S13	Wood Products and Furniture	7.169	6.333	9.664	11.280	7.445	12.358	12.056	8.145
S14	Paper Products and Printing	2.694	2.203	2.846	2.789	3.853	2.909	4.129	3.164
S15	Rubber	11.358	10.758	7.118	7.545	7.864	7.393	6.788	7.751
S16	Chemicals	5.710	5.408	3.578	3.793	3.953	3.717	3.412	3.788
S17	Petroleum Refining	9.715	8.863	3.328	1.593	9.428	9.246	8.159	6.924
S18	Other Chemicals	6.302	7.287	6.118	7.864	5.109	7.287	7.676	6.289
S19	Pharmaceutical and Veterinary	7.773	7.362	4.871	5.164	5.382	5.059	4.645	5.309
S20	Plastics	16.628	15.750	10.421	11.046	11.512	10.824	9.938	11.557
S21	Textiles	4.247	4.984	5.858	7.157	9.309	11.680	10.577	7.729
S22	Clothing	7.385	9.790	10.695	12.602	17.522	20.919	18.670	16.274
S23	Footwear	16.449	16.531	15.574	16.531	15.977	16.531	16.522	16.414
S24	Coffee	9.654	6.146	4.222	5.573	7.965	0.789	8.014	8.819
S25	Processed Vegetables	2.778	4.630	3.154	4.682	4.455	6.765	2.817	3.627
S26	Meat Packing Plants	1.954	1.954	1.954	1.954	1.954	1.954	1.954	1.954
S27	Dairy Products	8.923	8.923	8.923	8.923	8.923	8.923	8.923	8.924
S28	Sugar	15.665	2.171	15.665	2.123	2.646	15.665	2.171	9.391
S29	Vegetable Oil Meals	4.648	4.114	3.861	4.131	1.225	4.562	2.655	3.298
S30	Beverages and Other Food	3.157	3.157	8.808	17.901	23.977	29.250	1.595	8.000
S31	Other Manufacturing	12.127	9.100	12.200	11.871	5.131	8.119	11.181	10.140
	Mean	7.063	4.437	4.804	4.890	6.846	6.162	6.778	6.164

Source: prepared by the authors.

TABLE 7

Import tariffs on Brazilian exports, by destination, 1996 (% ad-valorem)

		Argentina	Other Mercosur	Nafta	Other FTAA	EU	Japan	ROW	Mean
S1	Agriculture	2.81	4.02	4.65	5.75	1.98	0.16	9.96	5.29
S2	Mining	13.19	10.05	0.34	21.45	0.02	0.01	22.89	1.95
S3	Oil and gas	8.06	1.22	0.22	4.20	0.01	0.00	0.67	2.07
S4	Nonmetallic Minerals	8.43	10.09	3.36	8.20	3.46	0.96	12.28	9.09
S5	Steel	6.05	4.86	1.60	4.60	1.91	0.78	4.64	6.50
S6	Nonferrous Metals	7.30	7.05	1.21	7.35	1.33	0.29	6.69	3.51
S7	Other Metal Products	9.85	7.41	1.41	7.43	2.54	0.67	9.21	10.86
S8	Machinery	2.84	2.42	0.57	3.50	1.25	0.07	4.56	5.45
S9	Electrical Equipment	4.09	3.49	0.82	5.03	1.80	0.10	6.56	5.16
S10	Electronic Equipment	1.44	1.17	0.42	2.25	1.23	0.13	2.90	5.63
S11	Automobile Industry	14.17	8.89	1.19	10.39	6.45	0.00	25.20	15.49
S12	Other Vehicles and Parts	6.10	2.55	0.14	3.21	0.89	0.00	9.84	4.00
S13	Wood Products and Furniture	9.15	13.18	0.23	11.72	1.43	0.16	8.55	4.14
S14	Paper Products and Printing	3.83	4.91	0.54	4.01	1.72	0.19	4.50	6.16
S15	Rubber	8.34	8.17	1.74	8.79	3.66	0.05	8.61	7.23
S16	Chemicals	4.19	4.11	0.87	4.42	1.84	0.03	4.33	5.92
S17	Petroleum Refining	3.41	0.02	2.84	12.43	3.14	0.13	25.26	4.30
S18	Other Chemicals	3.86	3.79	0.81	4.07	1.70	0.02	3.99	7.55
S19	Pharmaceutical and Veterinary	5.71	5.59	1.19	6.01	2.51	0.03	5.89	8.69
S20	Plastics	12.21	11.96	2.54	12.86	5.36	0.07	12.61	8.38
S21	Textiles	11.17	12.16	1.83	9.47	2.04	1.59	8.28	9.66
S22	Clothing	23.72	23.40	15.96	14.99	12.36	6.96	15.21	15.16
S23	Footwear	14.78	13.01	6.97	9.30	4.22	14.80	11.57	8.66
S24	Coffee	3.86	4.90	8.79	9.15	1.76	0.08	16.01	6.07
S25	Processed Vegetables	5.80	6.56	0.62	7.74	3.49	8.22	8.34	11.25
S26	Meat Packing Plants	4.25	1.20	0.25	5.62	20.45	51.03	8.75	44.82
S27	Dairy Products	15.97	18.04	16.38	7.18	116.34	350.49	100.75	53.62
S28	Sugar	16.15	7.97	60.51	25.57	74.96	139.87	14.46	21.72
S29	Vegetable Oil Meals	4.69	4.33	0.00	8.86	0.00	0.00	12.64	15.71
S30	Beverages and Other Food Products	25.48	34.07	3.03	30.40	15.43	36.26	35.88	13.02
S31	Other Manufacturing	10.66	5.78	1.01	10.62	3.34	1.14	7.24	8.85
	Mean	9.36	10.11	3.25	9.68	5.81	6.05	14.18	7.95

Source: prepared by the authors.

TABLE 8
Foreign Trade Structure, by Destination and Source: Sao Paulo, 1996

		Exports				Imports			
		Market Share			Sectoral	Market Share			Sectoral
		FTAA	EU	Other markets	Share	FTAA	EU	Other markets	Share
S1	Agriculture	0.0860	0.6082	0.3058	0.0196	0.9228	0.0360	0.0412	0.0203
S2	Mining	0.8386	0.1614	0.0000	0.0001	0.6759	0.0943	0.2298	0.0042
S3	Oil and gas	0.6706	0.1748	0.1546	0.0002	0.3895	0.0347	0.5760	0.0039
S4	Nonmetallic Minerals	0.6855	0.1396	0.1748	0.0002	0.4589	0.3963	0.1447	0.0080
S5	Steel	0.5038	0.1004	0.3957	0.0403	0.3158	0.5225	0.1617	0.0074
S6	Nonferrous Metals	0.4232	0.2553	0.3214	0.0334	0.6942	0.1950	0.1108	0.0112
S7	Other Metal Products	0.7322	0.1389	0.1289	0.0123	0.2972	0.5129	0.1899	0.0173
S8	Machinery	0.7035	0.1830	0.1134	0.0745	0.3799	0.4822	0.1378	0.0873
S9	Electrical Equipment	0.8540	0.0882	0.0579	0.0518	0.3929	0.3671	0.2401	0.0363
S10	Electronic Equipment	0.6978	0.1462	0.1560	0.0347	0.3951	0.3634	0.2415	0.1356
S11	Automobile Industry	0.8531	0.0350	0.1119	0.0643	0.4736	0.4386	0.0879	0.0815
S12	Other Vehicles and Parts	0.5961	0.3361	0.0679	0.1319	0.5707	0.3899	0.0394	0.1146
S13	Wood Products and Furniture	0.6362	0.1928	0.1711	0.0070	0.4467	0.4024	0.1508	0.0032
S14	Paper Products and Printing	0.4752	0.1568	0.3680	0.0276	0.6462	0.2970	0.0569	0.0325
S15	Rubber	0.8239	0.0802	0.0960	0.0231	0.4182	0.2370	0.3448	0.0125
S16	Chemicals	0.8808	0.0486	0.0706	0.0120	0.4773	0.2939	0.2288	0.0396
S17	Petroleum Refining	0.4828	0.2460	0.2713	0.0004	0.4242	0.3698	0.2060	0.0607
S18	Other Chemicals	0.6406	0.1622	0.1971	0.0264	0.4674	0.3406	0.1920	0.0297
S19	Pharmaceutical and Veterinary	0.8362	0.0907	0.0730	0.0150	0.4172	0.4870	0.0958	0.0446
S20	Plastics	0.8324	0.0882	0.0794	0.0046	0.5749	0.3056	0.1194	0.0117
S21	Textiles	0.7544	0.0849	0.1605	0.0218	0.4742	0.1331	0.3928	0.0287
S22	Clothing	0.7531	0.1798	0.0672	0.0025	0.3984	0.0948	0.5069	0.0048
S23	Footwear	0.3869	0.3686	0.2445	0.0196	0.3741	0.0529	0.5730	0.0036
S24	Coffee	0.2513	0.4564	0.2923	0.0169	0.1959	0.1397	0.6645	0.0000
S25	Processed Vegetables	0.7638	0.1443	0.0918	0.0516	0.2756	0.4360	0.2884	0.0031
S26	Meat Packing Plants	0.1646	0.6605	0.1748	0.0097	0.8951	0.0593	0.0456	0.0014
S27	Dairy Products	0.6992	0.0017	0.2992	0.0005	0.8039	0.1012	0.0949	0.0137
S28	Sugar	0.1284	0.0105	0.8611	0.0521	0.7576	0.2112	0.0312	0.0002
S29	Vegetable Oil Meals	0.2476	0.6168	0.1358	0.0117	0.4980	0.3749	0.1272	0.0043
S30	Beverages and Other Food Products	0.2436	0.3929	0.3635	0.0379	0.6127	0.2340	0.1533	0.0200
S31	Other Manufacturing	0.8859	0.0739	0.0403	0.0072	0.2224	0.1459	0.6317	0.0181
	Services	0.5723	0.2017	0.2261	0.1891	0.4537	0.3270	0.2193	0.1400
	Total	0.5854	0.2028	0.2118	1.0000	0.4706	0.3499	0.1796	1.0000

Source: Domingues (2002)

TABLE 9
Foreign Trade Structure, by Destination and Source: Other Regions in Brazil, 1996

		Exports				Imports			
		Market Share			Sectoral	Market Share			Sectoral
		FTAA	EU	Other markets	Share	FTAA	EU	Other markets	Share
S1	Agriculture	0.1971	0.6944	0.1085	0.0436	0.9536	0.0105	0.0358	0.0428
S2	Mining	0.1716	0.3719	0.4565	0.0801	0.8256	0.0524	0.1220	0.0070
S3	Oil and gas	0.5205	0.1387	0.3408	0.0003	0.4397	0.0500	0.5102	0.0910
S4	Nonmetallic Minerals	0.4605	0.3281	0.2114	0.0214	0.3548	0.3202	0.3249	0.0093
S5	Steel	0.5237	0.1099	0.3665	0.0982	0.3760	0.3882	0.2358	0.0098
S6	Nonferrous Metals	0.2281	0.2318	0.5401	0.0499	0.6662	0.1423	0.1915	0.0151
S7	Other Metal Products	0.6527	0.1263	0.2211	0.0223	0.2348	0.6573	0.1080	0.0182
S8	Machinery	0.7836	0.1174	0.0990	0.0200	0.3879	0.4288	0.1834	0.0910
S9	Electrical Equipment	0.6914	0.1973	0.1114	0.0134	0.3253	0.1409	0.5338	0.0427
S10	Electronic Equipment	0.6665	0.2356	0.0979	0.0089	0.3463	0.2905	0.3633	0.1171
S11	Automobile Industry	0.6918	0.2418	0.0663	0.0124	0.5088	0.3359	0.1553	0.0118
S12	Other Vehicles and Parts	0.6127	0.1235	0.2638	0.0361	0.9045	0.0783	0.0172	0.0310
S13	Wood Products and Furniture	0.3622	0.4359	0.2019	0.0355	0.7200	0.1895	0.0904	0.0049
S14	Paper Products and Printing	0.3704	0.3444	0.2852	0.0358	0.6671	0.2691	0.0639	0.0119
S15	Rubber	0.6862	0.2300	0.0837	0.0060	0.3691	0.2622	0.3687	0.0095
S16	Chemicals	0.4473	0.1835	0.3692	0.0195	0.5394	0.2158	0.2448	0.0295
S17	Petroleum Refining	0.5357	0.1364	0.3280	0.0464	0.3913	0.3537	0.2549	0.0944
S18	Other Chemicals	0.7705	0.1405	0.0890	0.0095	0.4406	0.2522	0.3071	0.0284
S19	Pharmaceutical and Veterinary	0.7138	0.2337	0.0525	0.0027	0.2204	0.4029	0.3767	0.0203
S20	Plastics	0.7512	0.0719	0.1769	0.0046	0.5488	0.2870	0.1644	0.0094
S21	Textiles	0.6258	0.2668	0.1074	0.0201	0.5077	0.1227	0.3696	0.0321
S22	Clothing	0.7059	0.2516	0.0424	0.0034	0.2873	0.1547	0.5580	0.0045
S23	Footwear	0.6511	0.2420	0.1069	0.0597	0.4935	0.0535	0.4528	0.0072
S24	Coffee	0.2271	0.5273	0.2455	0.0395	0.7621	0.0187	0.2192	0.0001
S25	Processed Vegetables	0.3201	0.4953	0.1845	0.0498	0.4667	0.4030	0.1303	0.0156
S26	Meat Packing Plants	0.1316	0.2673	0.6010	0.0357	0.9265	0.0167	0.0567	0.0050
S27	Dairy Products	0.8432	0.1122	0.0446	0.0006	0.5919	0.1912	0.2169	0.0039
S28	Sugar	0.3019	0.0205	0.6775	0.0165	0.5368	0.1021	0.3611	0.0002
S29	Vegetable Oil Meals	0.2307	0.1443	0.6249	0.0943	0.6461	0.2794	0.0744	0.0064
S30	Beverages and Other Food Products	0.0409	0.6132	0.3459	0.0121	0.6651	0.1535	0.1815	0.0201
S31	Other Manufacturing	0.8413	0.1093	0.0494	0.0117	0.1850	0.1378	0.6772	0.0329
	Services	0.3776	0.3046	0.3179	0.0900	0.4809	0.2112	0.3080	0.1769
	Total	0.4029	0.2741	0.3232	1.0000	0.4659	0.2351	0.2991	1.0000

Source: Domingues (2002)

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