Interregional Impacts of Trade Liberalization Strategies in Brazil

Edson Paulo Domingues, Mauro Borges Lemos

Centre for Development and Regional Planning,
Federal University of Minas Gerais (Cedeplar-UFMG),
Belo Horizonte, MG, Brazil

Abstract

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 interregional economic system, divided into two regions – São Paulo and Other Brazilian Regions. 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: Regional Modeling, Trade Policy, General Equilibrium

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A preocupação deste trabalho é avaliar implicações regionais de políticas de integração comercial do Brasil. Para isso, um modelo inter-regional de equilíbrio geral computável é utilizado, de forma a possibilitar, num quadro teórico e aplicado consistente, a implementação de simulações de política comercial. O modelo desenvolvido divide a economia brasileira em duas regiões, São Paulo e Outras Regiões do Brasil, e permite uma representação detalhada tanto dos fluxos de comércio externo dessas áreas como da estrutura de inter-relações regionais na economia brasileira. Por meio de exercícios de simulação, quatro alternativas de política comercial são analisadas (Alca, UE-Mercosul, Rodada do Milênio e Outros Mercados), de forma a estabelecer um quadro detalhado (nacional, regional e setorial) dos impactos projetados. Os resultados indicam que diferentes opções de abertura tendem a favorecer a região mais desenvolvida do país (São Paulo), e que os efeitos de inter-relação da economia paulista com o restante do país representam um importante efeito indireto positivo.

⋆ *Email address*: epdomin@cedeplar.ufmg.br (Edson Paulo Domingues).

1 Introduction

The aim of the present study is to assess the *ex-ante* regional and sectoral implications of trade integration policies for Brazil. A concern also exists with equity: do regional inequalities tend to increase or decrease? What sectors and regions benefit more from the integration process? The discussion of aspects regarding the Brazilian trade strategy should consistently consider the effects of trade integration policies on Brazilian macroregions and states. The Brazilian economy is not domestically homogenous, because there are remarkable contrasts between sectors and regions. Therefore, different spatial effects should be expected from economic policies, such as integration processes.

The analysis of the issues mentioned above requires an appropriate methodology that considers interregional and intersectoral relations in a systematic way, as well as the international inclusion of local economies. In general, the impacts of trade liberalization and of regional integration have been considered in different contexts [1]. Computable general equilibrium (CGE) models have been successfully applied in this area, and examples for the Brazilian economy have been described in the literature. The interregional specification in CGE models is particularly appealing, as it explicitly recognizes the interregional channels of the economic system (Haddad, 1999). Partial equilibrium studies, which require a reasonably smaller amount of information, produce biased estimates by ignoring that the regional integration process is a complex general equilibrium phenomenon.

In this study, an interregional CGE model for the Brazilian economy is used to analyze the regional implications of different trade

[1] For a review of studies on this issue, see Castilho (2002) and Bonelli and Hahn (2000).

policies. The specification of this model divides the Brazilian economy into two regions: São Paulo and the Rest of Brazil. The first one represents the economic space of the state of São Paulo, whereas the second one represents the remaining Brazilian states. Albeit simple, this regionalization captures important aspects of the Brazilian interregional system, given the importance of the economy of the state of São Paulo.

Apart from the introduction, the present paper is divided into four sections. Section 2 describes some characteristics of the CGE model and the simulations performed with the model. Section 3 shows the results of these simulations. Finally, section 4 concludes.

2 The SPARTA Model and Simulations

SPARTA (*São Paulo Applied Regional Trade Analysis*) is an interregional computable general equilibrium model developed to analyze the economy of São Paulo and the rest of Brazil. Its theoretical structure is similar to that of the B-MARIA model (Haddad (1999)). Both models follow the Australian general equilibrium modeling tradition; they resemble Johansen's models, where the mathematical structure is represented by a set of linearized equations and the solutions are obtained as growth rates. In this modeling tradition, there are other models for the Brazilian economy, such as the following: PAPA (Guilhoto (1995)), EFES (Haddad and Domingues (2001)) and its extension, and EFES-IT (Haddad et al. (2002)).

The SPARTA model divides the Brazilian economy into two endogenous regions: São Paulo and other Brazilian Regions, and identifies seven exogenous foreign markets: Argentina, Rest of

Mercosur, Rest of the FTAA, Nafta, European Union, Japan and Rest of the World. This regionalization of the foreign market is aimed to simulate the impact of trade policy strategies in the form of tariff reductions for specific blocs and sectors.

The model was calibrated for 1996, and 42 productive sectors and investment goods sectors were specified for each region. Productive sectors use two local primary factors (capital and labor). The final demand encompasses household consumption, investment, exports, and regional and federal government spending. Regional governments are exclusively local sources of demand and spending, including the state and municipal spheres of public administration in each region. The complete model contains 380,762 equations and 388,319 variables. The main innovation of the SPARTA model is the detailed treatment of foreign trade flows, with the specification of origin and destination markets for regional imports and exports. This specification follows that one implemented in the EFES-IT model (Haddad and Domingues (2001)), and is common in global and national models. Appendix 1 shows the core of the SPARTA model[2].

The SPARTA model was used in the analysis of the impact of four trade policy strategies: 1) formation of the FTAA (Free Trade Area of the Americas), 2) agreement between the European Union and Mercosur, 3) agreement between Brazil and other markets (China, India and other countries, excluding those

[2] The model was implemented using the GEMPACK program (Harrison and Pearson (2002)).The database was calibrated using the interregional São Paulo/Rest of Brazil input-output matrix estimated in Haddad and Domingues (2001). A previous version of the SPARTA model was used for the analysis of the interregional impacts of tax policies Domingues and Haddad (2003). A miniature version of the model is available from the authors upon request or at *www.econ.fea.usp.br/nereus/*.

in items 1 and 2; and 4) full agreement with all countries. Table 1 summarizes the characteristics of these four simulations. The simulations were performed in a long-term economic environment, which will be described in detail in the result analysis, whose major characteristic is the possibility of migration and interregional migration of investment in the Brazilian economy. Simulations represent the bilateral tariff liberalization in 31 industrial sectors and in the agricultural sector. Service sectors were not included in any of the trade liberalization simulations due to their different characteristics of tariff protection and also because they usually are the result of specific negotiations whose agreements are implemented in the longer run (Oliveira-Jr. (2000)).

The creation of FTAA was proposed by the USA in 1994, during the Miami Summit, and was accepted by 34 countries (except Cuba). Since then, several stages and meetings have been held in order to discuss timetables and proposals for the FTAA. Brazil has actively participated in FTAA discussions from the very beginning, and has taken on a role of leadership among Mercosur countries. The Quebec Summit (April 2001) established December 2004 as the deadline for the negotiation of the FTAA, with effective implementation of agreements from 2005 on. The FTAA simulation seeks to capture the impact of import tariff liberalization on industrial and agricultural goods between Brazil and the bloc countries.

Table 1. Trade liberalization simulations using the SPARTA model

Simulation	Regions in trade liberalization	Sectors in trade liberalization	Closure
FTAA	São Paulo, Other Brazilian Regions, Argentina, Rest of Mercosur, Nafta, Rest of the FTAA	32 (agricultural and industrial sectors)	Long run
EU-Mercosur	São Paulo, Other Brazilian Regions, Argentina, Rest of Mercosur, European Union	32 (agricultural and industrial sectors)	Long run
Other Markets	São Paulo, Other Brazilian Regions, Japan, Rest of the World*	32 (agricultural and industrial sectors)	Long run
Full Agreement	São Paulo, Other Brazilian Regions, Argentina, Rest of Mercosur, Nafta, Rest of the FTAA, European Union, Japan, Rest of the World*	32 (agricultural and industrial sectors)	Long run Long run

*Rest of the World: all countries except Latin America, Nafta, the European Union and Japan.

Concomitantly with FTAA negotiations, Brazilian authorities have taken part in discussions that involve an agreement between Mercosur and the European Union. The negotiations between the European Union and Mercosur began in 1995. In March 2001, the European Union announced to Mercosur diplomats that they would make a concrete proposal for import tariff liberalization, including those tariffs levied on agricultural products. Meetings between the bloc countries have been held regularly and, in principle, a final agreement was scheduled for late 2004. The European Union-Mercosur simulation aims to capture this alternative to trade liberalization.

The similarities of the strategic positions of developing countries in negotiations with the World Trade Organization (WTO) have led to the hypothesis of Brazilian trade integration with other developing countries, such as South Africa, India and China. The growth of Brazilian foreign trade with these countries after 2001 has sparked Brazil's interest in establishing trade agreements in these markets, reviving the South-South trade policy strategies conceived in the 1970s. Even though the discussions about this possibility have been sporadic and poorly structured, it seems an important alternative to the position of the Brazilian government and of other developing countries regarding multilateral negotiations at the WTO. This alternative is dealt with in the Other Markets simulation.

Finally, the fourth simulation, called Full Agreement, consists of tariff liberalization in all markets, as proposed in the WTO Millennium Round negotiations initiated in Doha. This hypothesis seems hard to implement in the short run, due to the results of the latest WTO summit meetings and to the advancement of bilateral agreements. On the other hand, this result is a comparative benchmark for the analysis of the impacts of other simulations.

The simulations implemented with the model represent the liberalization of bilateral import tariffs in each alternative of trade liberalization. Import tariff liberalization in Brazil for products from the specified integration bloc occurs directly by shocks that remove the sector's import tax. Tariff liberalization of Brazilian exports in foreign markets is approached by means of "subsidies" to the import tariff in that sector and in that country. The value of this subsidy is calculated so as to cancel out the effect of import tariffs on foreign markets[3]. The next section will present the results and the main characteristics of the models and of the simulations that generate them.

3 Results

The set of shocks specified to each simulation means reduction in the cost of Brazilian imports from the bloc countries and lower prices for Brazilian exports to this market. Based on these shocks, there is a set of sectoral and regional decisions concerning supply, demand, consumption and investment. The CGE model deals with all these changes in a simultaneous and integrated way. The results should therefore be seen as the product of general equilibrium relationships that characterize the specification of Brazilian economy represented by the SPARTA model. Table 2 shows the results for some selected macroeconomic variables, indicating their percentage variation between the base year and the new equilibrium.

[3] The database of the SPARTA model uses the tariff protection information from the GTAP database (Hertel (1997)), a benchmark in trade policy studies with general computable equilibrium models, allowing for some comparison with other trade integration studies. The method used for the construction of these tariffs was presented in Domingues and Haddad (2002).

Table 2
Selected Results for Brazil in the Long Run

Simulation	FTAA	EU-Mercosur	Other Market	Full Agreement
Real GDP (%var.)	0,359	0,347	0,064	0,607
Real Household Consumption (%var.)	-0,441	-0,389	-0,705	-1,478
Foreign Trade Balance (var.R$ bi)*	2,327	1,932	2,897	6,613
Exports (%var.)	4,290	4,367	4,891	12,538
Imports (%var.)	0,167	0,855	-0,193	0,781
Real Investment (var.%)	0,634	0,719	-0,353	0,735
Use of Labor (%var.)	0,187	0,185	0,032	0,291
Use of Capital (%var.)	0,234	0,239	0,190	0,617
Labor/Capital Relative price[a] (%var.)	-0,130	-0,165	0,016	-0,175

* currency as of 1996. [a] % variation of nominal wage minus % variation in the price of capital.

The results indicate that the agreement with the greatest impact on the GDP is the Full Agreement, which is similar to the conclusion of the WTO Millennium Round negotiations. This is an expected result, since the other three simulations can be regarded as subsets of this simulation, as they represent different sets of shocks[4]. The results for GDP components are very similar in the FTAA and EU-Mercosur simulations; the major difference lies in the greater expansion of imports in the latter one. The Other Markets simulation has a small impact on national GDP, although it produces greater foreign trade balance and larger increase in exports. In this case, the small increase in GDP is associated with the reduction in real investment, the only simulation in which this occurs.

It is important to understand this result in the light of the long-

[4] If the results for the same variable in the three simulations are added up, a double counting is verified, because the FTAA and EU-Mercosur simulations both include liberalization to Mercosur.

run closure of the model. GDP variations reflect expenditure variation and factor income variation, by the basic macroeconomic identity. Some GDP components on the expenditure side and income side must be endogenous so that this equality occurs. On the expenditure side, government deficit is exogenous, so the taxation on the factor income is adjusted to ensure that the (federal government) deficit is kept constant [5] . Liberalization implies reduction in the collection of import tariffs and increase in the expenditure with export subsidies. Thus, the tax on the factor income increases in order to restore the deficit to the base-year level, and the reduction in the available household income implies a decrease in real household consumption (in all simulations). Since trade balance response is endogenous and household consumption is linked to government deficit, investment is the expenditure component that equates GDP variation with income variation (capital and labor). In the Other Markets simulation, there is a crowding out effect of the trade balance on investment, since a decrease in household consumption is not enough to restore the equilibrium. In the other simulations, investment has to increase in order to ensure macroeconomic equilibrium.

Haddad et al. (2002) analyzed the impact of trade policies with a national CGE model coupled to an interstate trade matrix for Brazil. This work concluded that the European Union option produces a greater impact on the GDP (0.24%), which is higher than the effect of the FTAA (0.14%). According to this paper, a full agreement would mean an impact on the national GDP

[5] An alternative closure would be to regard the federal government deficit as endogenous, such that changes in tax collection would not imply compensatory tax variations. In this case, government consumption would respond to the variation in revenues, and not to household consumption, as is the case of the analyzed simulations. This alternative has little interference with relevant results in this study.

of 0.61%. The latter result is quite similar to the one obtained with the SPARTA model, which also indicates the EU-Mercosur simulation as being better than the FTAA option, although its magnitude is greater.

Macroregional and sectoral results may help us understand national results. In the general equilibrium model, national results are weighted averages of the respective regional results. Macroregional results of the simulations (Table 3) indicate that the economy of São Paulo tends to be relatively benefited, also in the case of a Full Agreement. Only in the Other Markets simulation the Other Brazilian Regions show a relative gain in terms of GDP [6]. This result is mainly influenced by foreign trade balance, which showed the largest increase in the Other Markets simulation. One should note that the Other Markets simulation, although it has a greater impact on the foreign trade balance, it has the smallest impact on the domestic trade balance. This will be clear when sectoral results are shown.

[6] Negative results for GDP variation of Other Brazilian Regions can be interpreted as an additional effect on the region's growth path. For example, if the economy of this region grows 3% every year, the effect of the FTAA on the region reduces the growth rate to 2.873%.

Table 3. Selected Macroregional Results in the Long Run

Simulation	FTAA		EU-Mercosur		Other Markets		Full Agreement	
Domestic Region	SP	OR	SP	OR	SP	OR	SP	OR
Real GDP (%var.)	1,232	-0,127	1,259	-0,160	0,051	0,072	1,837	-0,076
Real Household Consumption (%var.)	0,905	-0,948	0,999	-0,912	-0,523	-0,774	0,587	-2,257
Foreign Trade Balance (var. R$ bi)*	0,616	1,657	0,419	1,500	0,929	1,934	1,962	4,696
Exports (var.%)	4,605	4,113	4,598	4,236	3,757	5,529	11,813	12,946
Imports (var.%)	1,575	-0,379	2,528	0,088	-0,791	0,169	2,187	0,009
Domestic Trade Balance (var. R$ bi)*	-2,780	2,780	-2,718	2,718	-1,524	1,524	-5,433	5,433
Real Investment (%var.)	4,497	-1,023	4,923	-1,084	-1,396	0,090	5,200	-1,181
Capital Stock (%var.)	0,570	0,077	0,613	0,065	0,000	0,278	0,870	0,499
Employment (%var.)	1,472	-0,409	1,456	-0,404	0,250	-0,069	2,321	-0,644

* currency as of 1996. SP: São Paulo; OR: Other Brazilian Regions.

The behavior of the domestic trade balance illustrates important features of the Brazilian interregional system. We can consider two components for the explanation of the interregional trade response: substitution effect and activity effect. The increase in the level of regional activity implies greater necessity for domestic imports; the decrease in the relative price of domestic imports (vis-à-vis exports) produces deficits due to the substitution effect. In the FTAA and EU-Mercosur simulations, we may observe that the economy of São Paulo reduces its domestic trade balance (and by definition, the Other Brazilian Regions increase their domestic trade balance). Thus, the increase in the level of activity of São Paulo produces an increase in its demand for domestic imports, an effect that is reinforced by the decrease in the relative price of these imports. The results indicate that the domestic trade balance works as a cushion for the negative impacts of trade liberalization in the Other Brazilian Regions.

Regional and sectoral investment suffers the impact of the shocks of tariff liberalization by the change in the rate of return on capital observed in the base year. The impact on the rate of return occurs through two channels: by the production cost of capital goods and by the price of capital. Given the share of imports on the composition of capital goods, tariff liberalization tends to increase the rate of return on capital in most sectors, ceteris paribus. Investment (capital creation) moves to the sectors that benefit more from the liberalization, since the increase in the level of activity requires additional units of capital. In addition, the rise in capital stock decreases the price of additional capital units. The movement of these components changes the rate of return on capital in each regional sector, and also the mean rate of return on capital in the region. The creation of sectoral capital is oriented in such a way as to restore differentials of capital return in the regions.

The simulation results indicate that investment is directed to São Paulo in the FTAA and EU-Mercosur simulations, and to Other Brazilian Regions in the Other Markets simulation [7]. The decrease in real investment in the Other Brazilian Regions in the FTAA and EU-Mercosur simulations indicates that the effect of tariff liberalization on imports has a less important impact on the cost of capital in the region. A Full Agreement would represent a relative transfer of capital to the economy of São Paulo. These results are closely related to the set of more/less favored sectors in each simulation, as will be shown further ahead.

Employment migrates to the economy of São Paulo in all simulations, even in the Other Markets simulation, in which the variation in the level of activity of the economy of São Paulo is relatively smaller. In this simulation, the increase in the level of activity in the Other Brazilian Regions occurs with reduction in the employment level and increase in the capital-labor ratio (in São Paulo, employment increases and the capital-labor ratio decreases) [8].

Haddad et al. (2002) concluded that São Paulo is one of the states that benefits the most from the FTAA (0.30% of growth in the level of activity). An agreement with the European Union represents a 0.26% gain for the economy of São Paulo, but it benefits more other Brazilian states. A Full Agreement has a 0.78% impact, and São Paulo is the sixth most benefited state. These results are different from those obtained with the SPARTA model. The main cause for this discrepancy probably results from

[7] The result for the national level of investment was a decrease in the Other Markets simulation only (see Table 3). Thus, the migration of investment to the Rest of Brazil in this simulation occurs through a decrease in aggregate investment.

[8] The model adopts a 0.5 price elasticity of substitution between capital and labor in all sectors.

the use of an interstate trade model with fixed coefficients for the decomposition of national results of the CGE model, which implies that the structure of the interstate trade does not change, which can be considered a very restrictive hypothesis in the long run.

3.1 Sectoral impacts

For the better understanding of simulation results, we need a more detailed observation of sectoral simulation results. Table 4 shows the projections of the sectoral level of activity in São Paulo for each simulation. Table 5 shows projections of the sectoral level of activity in Other Brazilian Regions. Variations in sectoral activity also represent the direction of the variation in sectoral employment.

Sectoral results may be partially understood through the direction of the sectoral-regional foreign trade and shock on tariffs. The direction of sectoral trade is an indication of direct gains from exports and of losses from the increase in competition in terms of imports, for each regional sector. One should bear in mind that the projected result for the sectoral level of activity is a product of the direction of trade and tariffs in each simulation and also of sectoral interrelationships, of linkage effects and spillovers, of supply constraints, and other factors captured by the general equilibrium model. Next, we will analyze some sectors and show these relationships.

Table 4 shows the sectoral result in São Paulo for each simulation. Let us consider the FTAA simulation. The sectors that benefit most are Textiles, Processed Vegetables and Machinery and Tractors. The textile sector represents 2.18% of state exports, and 75.44% of these exports are bound to FTAA markets.

Textiles represent 2.87% of imports, and 47.42% is imported from the FTAA. The result of tariff liberalization of the sector in the FTAA tends to be an increase in the level of activity of São Paulo. The comparison with the result of small growth in the textile sector in the Other Markets simulation may be related, among other factors, to the situation of foreign trade in this case. Textile imports concentrate on these markets (39.28%) and only 16.05% of exports is destined to them.

The Machinery and Tractors sector represents a well-known segment of São Paulo exports for the FTAA markets. This sector accounts for 7.45% of state exports, 70.35% is destined to the FTAA markets and 18.33% to the European Union. The sector has an important share in imports, 8.73% of the total imports, with origin distributed between the FTAA (37.99%) and the European Union (48.22%). This situation partly explains the relative expansion of the level of activity in the economy of São Paulo in the FTAA and EU-Mercosur simulations, and a more modest growth in the Other Markets simulation.

Electronic Material is another example. This is the sector with the largest demand for imports in São Paulo (13.56%), distributed between the FTAA (39.51%), European Union (36.34%) and Other Markets (24.15%). Exports in this sector are less representative (3.47% of the total) and are mainly to the FTAA (69.78%), to Other Markets (15.60%) and to the European Union (14.62%). Thus, the positive result of the sector in the FTAA and EU-Mercosur simulations is also related to this position in foreign market. In the Other Markets simulation the smaller migration of exports to this market and the larger competition with imports partly explain the negative result for the level of activity of this sector.

Table 5 shows the results projected for the level of activity of Other Brazilian Regions in the four simulations. Notably, the

Other Markets simulation brings benefits to a larger number of sectors and reveals expressive gains, such as in the case of Mineral Extraction, Vegetable Oils, Meats and Steel. This result is quite obvious, given the large participation of these exports in Other Brazilian Regions, around 21% of the total, the main destination to Other Markets, and significant tariff liberalization in this simulation. Moreover, the imports of these products are poorly significant [9] .

In the opposite case, we have the Electronic Material sector of Other Brazilian Regions, which shows a decrease in the level of activity in all simulations. This sector plays an important role in imports of the region (11.71% of the imported amount) and is poorly representative of the exports (0.89% of the exported amount). Imports of this good come from the FTAA (34.63%), European Union (29.05%) and Other Markets (36.33%). Therefore, the increase in competition with imports seems to be a major cause of the projected decrease in the level of activity of this sector [10] .

Sectoral results help explain the causes of the Other Markets simulation, which relatively benefits the Other Brazilian Regions, but not São Paulo, as occurs in the FTAA and EU-Mercosur simulations. In the Other Markets simulation, the major products directly affected by tariff liberalization are very representative of exports in this region, and the competition with imports is minimal. Furthermore, the participation of these sectors in regional production is quite large.

The effect on employment reduction in Other Brazilian Regions

[9] These products represent the major source of foreign market surplus of the region, 1.60% of the gross regional product.
[10] The sector's trade has the largest foreign trade deficit of the region, −0.90% of its gross regional product.

is related to the cost structure of the most directly benefited sectors. If we consider three of these sectors (Oil Refinement and Petrochemicals, Steel and Vegetable Oils), we observe capital/labor ratios way above the mean. This way, an increase in production requires a more significant elevation in the capital factor in relation to the labor factor in the region, hence the increase in investment and decrease in employment found in this simulation (Table 3).

In summary, sectoral impacts represent the source of gains of the economy of São Paulo in FTAA, EU-Mercosur and Broad Agreement simulations. In these simulations, the economy of São Paulo is benefited due to the external inclusion of the sectors that most benefited from the liberalization of these foreign markets, besides efficiency gains from import tariff liberalization. In the Other Markets simulation, the Other Brazilian Regions captured most benefits through direct exports of traditional products on their list, besides the positive effect of the growth of São Paulo's economy. This is an important aspect highlighted by the results, since the strong regional relationship between São Paulo and other Brazilian states causes remarkable impact on this region, even when this region is not the most directly benefited one.

Table 4
Sectoral projections of the long-term level of activity – São Paulo (var.%)

Sector		Simulation FTAA	EU-Mercosur	Other Markets	Full Agreement
S1	Agriculture and animal husbandry	0,790	0,990	0,880	2,580
S2	Mineral extration	1,730	1,660	2,330	4,940
S3	Extraction of oil, gas and others	0,580	0,700	0,250	1,550
S4	Non-metallic minerals	1,260	1,310	0,030	1,890
S5	Steel	1,690	1,380	1,410	3,770
S6	Non-ferrous metals	1,350	1,470	1,280	3,340
S7	Other metallurgical products	1,170	1,100	0,340	1,950
S8	Machinery and tractors	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	Cars, trucks and buses	0,910	0,900	-0,440	0,610
S12	Other vehicles, parts and accessories	0,860	0,890	0,720	2,000
S13	Wood products and furniture	0,680	0,720	-0,330	0,490
S14	Paper and printing	0,620	0,600	0,370	1,240
S15	Rubber	0,950	0,780	0,460	1,790
S16	Non-petrochemical products	0,820	0,890	0,500	1,620
S17	Oil refinement and petrochemicals	1,120	0,570	1,660	3,110
S18	Miscellaneous chemical products	1,050	1,110	0,690	2,360
S19	Pharmaceuticals and perfumery	0,710	0,640	-0,180	0,680
S20	Plastic material	0,760	0,790	0,350	1,480
S21	Textiles	2,170	1,790	0,170	3,290
S22	Clothing and accessories	0,370	0,580	-0,970	-0,460
S23	Footwear, leather and fur products	0,130	-0,210	-0,330	0,710
S24	Coffee industry	1,110	0,870	0,740	2,320
S25	Processed vegetables	1,990	1,930	1,010	3,650
S26	Meats	0,770	2,590	1,320	4,350
S27	Milk and dairy products	-0,390	-0,410	0,570	0,410
S28	Sugar industry	0,620	0,170	1,280	1,970
S29	Vegetable oils	0,650	0,660	1,200	2,320
S30	Beverages and other foods	0,670	0,590	0,620	1,550
S31	Miscellaneous industries	0,700	0,750	-0,200	1,020

Table 5
Sectoral projections of the long-term level of activity – Other Brazilian Regions (var.%)

Sector		FTAA	EU-Mercosur	Other Markets	Full Agreement
S1	Agriculture and animal husbandry	0,690	0,840	1,190	2,740
S2	Mineral extraction	2,130	1,950	5,070	8,240
S3	Extraction of oil, gas and others	0,080	0,190	0,280	0,920
S4	Non-metallic minerals	0,550	0,570	0,160	1,040
S5	Steel	1,590	1,190	1,560	3,680
S6	Non-ferrous metals	0,800	0,940	1,220	2,520
S7	Other metallurgical products	0,580	0,380	0,600	1,290
S8	Machinery and tractors	0,150	0,010	0,660	0,880
S9	Electrical equipment	0,010	0,000	0,200	0,300
S10	Eletronic equipment	-0,710	-0,680	-0,290	-1,310
S11	Cars, trucks and buses	-0,230	-0,420	-0,010	-0,410
S12	Other vehicles, parts and accessories	0,290	0,250	1,230	1,720
S13	Wood products and furniture	0,010	0,060	0,040	0,110
S14	Paper and printing	0,210	0,250	0,530	0,920
S15	Rubber	0,310	0,150	0,230	1,650
S16	Non-petrochemical products	0,310	0,340	0,480	0,880
S17	Oil refinement and petrochemicals	1,110	0,580	1,860	3,270
S18	Miscellaneous chemical products	0,760	0,860	0,830	2,140
S19	Farmaceuticals and perfumery	-0,430	-0,480	-0,180	-0,910
S20	Plastic material	0,150	0,160	0,410	0,660
S21	Textiles	1,660	1,300	-0,100	2,310
S22	Clothing and accessories	-1,120	-0,950	-1,330	-2,980
S23	Footwear, leather and fur products	0,140	-0,070	0,210	2,350
S24	Coffee industry	-0,100	-0,170	0,180	0,010
S25	Processed vegetables	0,050	0,070	0,350	0,340
S26	Meats	-0,250	0,710	2,120	2,810
S27	Milk and dairy products	-1,070	-0,960	0,220	-0,800
S28	Sugar industry	1,100	-0,180	1,020	2,090
S29	Vegetable oils	0,610	0,450	3,040	3,840
S30	Beverages and other foods	-0,780	0,980	0,080	-1,330
S31	Miscellaneous industries	-0,080	-0,030	-0,170	0,030

Simulation: FTAA, EU-Mercosur, Other Markets, Full Agreement.

4 Final Remarks

Economic theory and empirical evidence indicate that trade agreements tend to increase the efficiency of resource allocation. The relationship between trade liberalization and growth processes from a theoretical and empirical standpoint, has been cast into doubt and clearly depends on the real characteristics of the economies at issue (Rodrik (2002)). The estimates obtained herein do not reject the hypothesis of long-term static gains from the implementation of trade agreements, including growth factor.

The results obtained herein showed the different sectoral and regional impacts that trade policy alternatives tend to produce on the Brazilian economic space. The tendency towards an increase in regional inequality, represented by the relative expansion of the level of activity and investment in the most developed Brazilian region (São Paulo), was observed in the FTAA, European-Mercosur and Full Agreement simulations. The economy of São Paulo was not relatively benefited only in case of liberalization to Other Markets. The model and results revealed that the source of this phenomenon lies not only in the group of more and less directly benefited sectors in each of the simulations, but also in the spatially differentiated inclusion of sectors in the Brazilian economy and in regional interrelationships. The most internationalized characteristic of So Paulo's sectors allows the state economy to obtain positive results in options where trade liberalization implies greater competition with imports (FTAA and EU-Mercosur), producing a positive activity effect on the other Brazilian regions. In the Other Markets simulation, the concentration of liberalization on the exports of other Brazilian regions and the low competition with imports produce a relative gain in relation to the economy of São Paulo.

Finally, we have to include a methodological note about the application and use of general equilibrium models. The results shown herein represent the projections that reflect the trajectory of the economy until a new state of equilibrium is achieved. These results should be interpreted qualitatively and not taken *as stricto senso* predictions. However, this characteristic does not make them less important than those obtained in econometric partial equilibrium analyses of trade policies (e.g. Maciente (2000); De-Negri et al. (2003)). Partial equilibrium models have numerous applications and qualities, but the extensive analysis of the impact of trade liberalization processes requires that the relation between markets, regions and components of the economic system be explicitly taken. The major hindrance to the use of general equilibrium models seems to be related to the great effort put in to investigate this methodology. Nevertheless, the growing activity of Brazilian researchers in this field in recent years and the public dissemination of these models are an important step in the expansion of its use.

References

Bonelli, R. & Hahn, L. (2000). Resenha dos estudos recentes sobre relações comerciais brasileiras. Rio de Janeiro, IPEA, Texto para Discussão 708.

Castilho, M. R. (2002). Impactos de acordos comerciais sobre a economia brasileira: Resenha dos trabalhos recentes. Rio de Janeiro, IPEA, Texto para Discussão 936.

De-Negri, J. A., Arbache, J. S., & Silva, M. L. F. (2003). A formação da ALCA e seu impacto no potencial exportador brasileiro para os mercados dos Estados Unidos e do Canadá. Brasília, IPEA, Texto para Discussão 991.

Domingues, E. P. & Haddad, E. A. (2002). Matriz inter-regional de insumo-produto Minas Gerais/Resto do Brasil: Estimação e extensão para exportações. *Anais do X Seminário sobre a Economia Mineira, Diamantina*. BDMG/Fipe.

Domingues, E. P. & Haddad, E. A. (2003). Política tributária e re-localização. *Revista Brasileira de Economia*, 57:515–537.

Guilhoto, J. J. M. (1995). *Um Modelo Computável de Equilíbrio Geral Para Planejamento e Análise de Políticas Agrícolas (PAPA) Na Economia Brasileira.* PhD thesis, ESALQ/USP, Piracicaba.

Haddad, E. A. (1999). Regional inequality and structural changes: Lessons from the Brazilian experience. Aldershot, Ashgate.

Haddad, E. A. (2004). Retornos crescentes, custos de transporte e crescimento regional. Tese de Livre-Docência. São Paulo, IPE-USP.

Haddad, E. A. & Domingues, E. P. (2001). EFES – Um modelo aplicado de equilíbrio geral para a economia brasileira: Projeções setoriais para 1999-2004. *Estudos Econômicos*, 31:89–125.

Haddad, E. A., Domingues, E. P., & Perobelli, F. S. (2001). *Aspectos Estratégicos Da Política Comercial Brasileira*, volume 1, chapter Impactos setoriais e regionais da integração. IPEA/IPRI, Brasília, L. F. Tironi edition.

Haddad, E. A., Domingues, E. P., & Perobelli, F. S. (2002). Regional effects of alternative strategies for economic integration: The case of Brazil. *Journal of Policy Modeling*, 24:453–482.

Harrison, W. J. & Pearson, K. R. (2002). *An Introduction to GEMPACK*. IMPACT Project and KPSOFT, Australia. GEMPACK User Documentation GPD-1.

Hertel, T. W. (1997). *Global Trade Analysis: Modeling and Applications*. Cambridge University Press, New York.

Maciente, A. N. (2000). A formação da Alca e de um acordo de livre comércio entre o Mercosul e a União Européia: Uma análise comparada. Master's thesis, Universidade de São Paulo.

Oliveira-Jr., M. (2000). Uma análise da liberalização do comércio internacional de serviços no Mercosul. Brasília, IPEA, Texto para Discussão 727.

Rodrik, D. (2002). Estratégias de desenvolvimento para o novo século. In G. Arbix, A. Comin, M. Z. & Abramovay, R., editors, *Brasil, México, África Do Sul, Índia e China: Diálogo Entre Os Que Chegaram Depois*. Editora UNESP: Editora da Universidade de São Paulo, São Paulo.

Appendix 1. SPARTA Model [11] .

The functional forms of the equation sets of the core SPARTA model and the definitions of the groups of variables, parameters and coefficients are shown below.

The notation uses capital letters to represent the level of variables, and small letters for percentage variation. The superscripts $(u), u = 0, 1j, 2j, 3, 4, 5, 6$ refer respectively to production (0) and the six different uses of the products, per region, identified in the model: producers in sector $j(1j)$, investors in sector $j(2j)$, families (3), export buyers $(4f)$, regional government (5) and the federal government (6); the second superscript indicates the domestic region where the user of the input is located. Inputs are designated by subscript suns: the first one assumes values $1, ..., g$, for goods, $g + 1$, for primary factors, and $g + 2$, for "other costs" (basically, taxes and subsidies levied on production); the second subscript indicates the input source, where $b(1b)$ is the domestic region, $f(2f)$ is the foreign market, (1) indicates labor, (2) capital and (3) land. The symbol $(\cdot)$ is used to indicate the sum of an index.

In the simulations presented herein, the shocks were implemented by variables $t\,(\tau, i, s, (u)\,r)$ and $fp^{(4)r}_{(is)}$, using equations A7 and A9, respectively.

[11] We wish to express our thanks to Professor Haddad for supplying the initial material for this Appendix, which follows the notation of the B-MARIA model-27 (Haddad (2004), pg. 174–183). We take full responsibility for all errors and/or omissions.

Equations

(A1) Substitution between domestic goods from different domestic regions

$$x^{(u)r}_{(i(1b))} = x^{(u)r}_{(i(1\cdot))} - \sigma^{(u)r}_{(i)} p^{(u)r}_{(i(1b))} - \sum_{l\in S}(V\left(i,1l,(u),r\right)/\left(V\left(i,1\cdot,(u),r\right)\left(p^{(u)r}_{(i(1l))}\right)\right)$$

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

(A1) Substitution between imported goods from different sources

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

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

(A2) Substitution between domestic and imported goods

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

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

(A3) Substitution between labor, land and capital

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

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

(A4) Demand for composite intermediate goods, investment goods, primary factors and other costs

$x^{(u)r}_{(i\cdot)}\mu^{(u)r}_{(i\cdot)}z^{(u)r} + a^{(u)r}_{(i)}\ u = (kj)$ 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 demand for composite goods

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

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

(A6) Sectoral composition of output

$x^{(0j)r}_{(i1)} = z^{(1j)r} + \sigma^{(0j)r}\left(p^{(0)r}_{(i1)} - \sum_{t\in G}\left(Y\left(t, j, r\right)/Y\left(\cdot, j, r\right)\right)p^{(0)r}_{(t1)}\right)$

$j = 1, ..., h; i = 1, ..., g; r = 1, ..., R$

(A7) Indirect tax rates

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

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

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

(A8) Purchasing prices related to basic prices, margins and taxes

$V\left(i, s, (u), r\right)p^{(u)r}_{(is)} = \left(B\left(i, s, (u), r\right) + \sum_{\tau\in T}T\left(\tau, i, s, (u), r\right)\right)$
$\left(p^{(0)}_{(is)} + t(\tau, i, s, u, r)\right) + \sum_{m\in G}M\left(m, i, s, (u), r\right)p^{(0)r}_{(m1)},$

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

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

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

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

(A10) Regional government demands

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

$f = 1, ..., F$

(A11) Federal government demands

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

(A12) Demands for margins for domestic goods

$m, i = 1, ..., g;$

$(u) = (3), (4b)$ for $b = 1, ..., r, (5)$ and (kj) for $k = 1, 2;$

$x_{(m1)}^{(is)(u)r} = \theta_{(is)}^{(u)r} x_{(is)}^{(u)r} + a_{(m1)}^{(is)(u)r}$

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

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

(A13) Demand equals supply for regional domestic goods

$\sum_{j \in H} Y\left(l, j, r\right) x_{(l1)}^{(0j)r} = \sum_{u \in U} B\left(l, 1, \left(u\right), r\right) x_{(l1)}^{(u)r}$

$+ \sum_{i \in G} \sum_{s \in S} \sum_{u \in U} M\left(l, i, s, \left(u\right), r\right) x_{(l1)}^{(is)(u)r} \qquad l = 1, ..., g; r = 1, ..., R$

(A14) Revenues equal costs for regional sectors

$\sum_{l \in G} Y\left(l, j, r\right) p_{(l1)}^{(0)r} + a_{(l1)}^{(0)r} = \sum_{l \in G^*} \sum_{s \in S} V\left(l, s, \left(1j\right), r\right) \left(p_{(ls)}^{(1j)r}\right),$
$j = 1, ..., h; r = 1, ..., R$

(A15) Basic price of imported goods

$p_{(i(2f))}^{(0)} = p_{(i(2f))}^{(w)} - e + t_{(i(2f))}^{(0)}, \qquad i = 1, ..., g; f = 1, ..., F$

(A16) Cost of capital in regional sectors

$V\left(\cdot, \cdot, \left(2j\right), r\right) \left(p_{(k)}^{(1j)r} - a_{(k)}^{(1j)r}\right) = \sum_{i \in G} \sum_{s \in S} V\left(i, s, \left(2j\right), r\right)$
$\left(p_{(is)}^{(2j)r} + a_{(is)}^{(2j)r}\right), \qquad j = 1, ..., h; r = 1, ..., R$

(A17) Investment

$z^{(2j)r} = x_{(g+1,2)}^{(1j)r} + 100 f_{(k)}^{(2j)r}, \qquad j = 1, ..., h; r = 1, ..., R$

(A18) Capital accumulation in the $T+1$ period – comparative statics

$x_{(g+1,2)}^{(1j)r}\left(1\right) = x_{(g+1,2)}^{(1j)r} \qquad j = 1, ..., h; r = 1, ..., R$

(A19) Definition of rates of return

$r_{(j)}^{r} = Q_{(j)}^{r} \left(p_{(g+1,2)}^{((1j)r)} - p_{(k)}^{(1j)r}\right), \qquad j = 1, ..., h; r = 1, ..., R$

(A20) Relation between capital growth and rates of return

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

Other definitions in the core module of the CGE model include: indirect tax revenues, import volume, export volume, national and regional GDP components, regional and national price indices, wage settings, definitions of factor prices, and aggregate employment.

Table .1
Variables

Variable	Index ranges	Description
$x_{(is)}^{(u)r}$	$(u) = (3), (4), (5), (6)$ and (kj) for $k = 1, 2$ and $j = 1, \ldots, h$; if $(u) = (1j)$ then $i, \ldots, g + 2$; if $(u) \neq (1j)$ then $i = 1, \ldots, g$; $s = 1b, 2f$ for $b = 1, \ldots, q$; $f = 1, \ldots, F$; $ei = 1, \ldots, g$ and $s = 1, 2, 3$ for $i = g + 1$ $r = 1, \ldots, R$	Demand from user (u) in region r for good or primary factor (is)
$p_{(is)}^{(u)r}$	$(u) = (3), (4), (5), (6)$ and (kj) para $k = 1, 2$ e $j = 1, \ldots, h$; if $(u) = (1j)$ then $i = 1, \ldots, g + 2$; if $(u) \neq (1j)$ then $i = 1, \ldots, g$; $s = 1b, 2f$ for $b = 1, \ldots, q$; $f = 1, \ldots, F$; $ei = 1, \ldots, g$ and $s = 1, 2, 3$ for $i = g + 1$ $r = 1, \ldots, R$	Price paid by user(u) in region r for good or primary factor (is)
$x_{(i\cdot)}^{(u)r}$	$(u) = (3)$ and (kj) for $k = 1, 2$ and $j = 1, \ldots, h$ if $(u) = (1j)$ then $i = 1, \ldots, g + 1$; if $(u) \neq (1j)$ then $i = 1, \ldots, g$ $r = 1, \ldots, R$	Demand for composite good or primary factor i from user (u) in region r
$a_{(g+1,s)}^{(1j)r}$	$j = 1, \ldots, h$ and $s = 1, 2, 3$ $r = 1, \ldots, R$	Primary factor-saving technological change in region r
$a_{(i)}^{(u)r}$	$i = 1, \ldots g, (u) = (3)$ and (kj) for $k = 1,$ 2 and $j = 1, \ldots, h$ $r = 1, \ldots, R$	Technological change related to the use of good i by user (u) in region r
C^r		Total expenditure by regional families in region r
Q^r		Number of families
$z^{(u)r}$	$(u) = (kj)$ for $k = 1, 2$ and $j = 1, .., h$ $r = 1, \ldots, R$	Levels of activity: current production and investment by the sector in region r

Table .2
Variables

Variable	Index ranges	Description
$fq^{(4)r}_{(is)}$	$i = 1, ..., g; s = 1b, 2f$ for $b = 1, ..., q$; $f = 1, ..., F$; $r = 1, ..., R$	Shift (amount) in foreign demand curves in regional exports
$fp^{(4)r}_{(is)}$	$i = 1, ..., g; s = 1b, 2f$ for $b = 1, ..., q$; $f = 1, ..., F; r = 1, ..., R$	Shift (price) in foreign demand curves in regional exports
e		Nominal exchange rate
$x^{(is)(u)r}_{(m1)}$	$m, i = 1, ..., g; s = 1b, 2f$ 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 good $(m1)$ used as margin to facilitate the flow from (is) for (u) in region r
$a^{(is)(u)r}_{(m1)}$	$m, i = 1, ..., g; s = 1b, 2f$; for $b = 1, ..., q;\ f = 1, ..., F$; $(u) = (3), (4), (5), (6)$ and (kj) for $k = 1, 2$ and $j = 1, ..., h$ $r = 1, ..., R$	Technological change related to good $(m1)$ used as margin to facilitate the flow from (is) to (u) in region r
$x^{(0j)r}_{(i1)}$	$i = 1, ..., g; j = 1, ..., h$ $r = 1, ..., R$	Domestic production of good i by sector j
$p^{(0)r}_{(is)}$	$i = 1, ..., g; s = 1b, 2f$ for $b = 1, ..., q$; $f = 1, ..., F; r = 1, ..., R$	Basic price of good i in region r from source s
$p^{(w)}_{(i(2))}$	$i = 1, ..., g$	c.i.f. price(US$) of imports of good i
$t^{(0)}_{(i(2))}$	$i = 1, ..., g$	Power of the tariff on imports of good i
$t(\tau, i, s, (u)r)$	$i = 1, ..., g; \tau = 1, ..., t$; $s = 1b, 2f$ 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 tax τ on sales of good (is) to user (u) in region r
$f^{(2j)r}_{(k)}$	$j = 1, ..., h$ $r = 1, ..., R$	Capital shift terms specific to the regional sector
$f^{r}_{(k)}$	$r = 1, ..., R$	Capital shift terms in region r

Table .3
Variables

Variable	Index ranges	Description
$x^{(1j)r}_{(g+1,2)}(1)$	$j = 1, ..., h$ $r = 1, ..., R$	Capital stock in sector j of region r at the end of the year, i.e., capital stock available for use in the next year
$p^{(1j)r}_{(k)}$	$j = 1, ..., h$ $r = 1, ..., R$	Cost of construction of capital unit of sector j in region r
$f_{(\tau)}$	$\tau = 1, ..., t$	Shift term allowing uniform percentage variations in the power of tax τ
$f_{(\tau i)}$	$\tau = 1, ..., t$; $i = 1, ..., g$	Shift term allowing uniform percentage variations in the power of tax τ on good i
$f^{(u)}_{(\tau i)}$	$\tau = 1, ..., t$; $(u) = (3), (4), (5), (6)$ and (kj) for $k = 1, 2$ and $j = 1, ..., h$	Shift term allowing uniform percentage variations in the power of tax τ on good i and user (u)
$f^{(u)r}_{(\tau i)}$	$\tau = 1, ..., t$; $(u) = (3), (4), (5), (6)$ and (kj) for $k = 1, 2$ and $j = 1, ..., h$ $r = 1, ..., R$	Shift term allowing uniform percentage variations in the power of tax τ on good i and user (u) in region r
$f^{(5)r}_{(is)}$	$i = 1, ..., g; s = 1b, 2f$ for $b = 1, ..., q$; $f = 1, ..., F; r = 1, ..., R$	Source-specific shift term for regional government spending in region r
$f^{(5))r}$	$r = 1, ..., R$	Shift term for regional government spending in region r
$f^{(5)}$		Shift term for regional government spending
$f^{(6)r}_{(is)}$	$i = 1, ..., g; s = 1b, 2f$ for $b = 1, ..., q$; $f = 1, ..., F; r = 1, ..., R$	Source-specific shift term for federal government spending
$f^{(6)r}$	$r = 1, ..., R$	Shift term for federal government spending in region r
$F^{(6)}$		Shift term for federal government spending
ω		Mean rate of return on capital (short-term)
$r^{r}_{(j)}$	$j = 1, ..., h$ $r = 1, ..., R$	Rate of return specific to the regional sector

Table .4
Parameters, Coefficients and Sets

Symbol	Description
$\sigma^{(u)r}_{(i)}$	Parameter: elasticity of substitution between the alternative sources of good or factor i by user (u) in region r
$\omega^{(0j)r}$	Parameter: elasticities of transformation between outputs of different goods in sector j of region r
$\alpha^{(1j)r}_{(g+1,s)}$	Parameter: returns to scale for individual primary factors in sector j of region r
$\beta^{r}_{(i)}$	Parameter: marginal budget shares in the linear system of expenditure of good i in region r
$\gamma^{r}_{(i)}$	Parameter: subsistence parameter in the linear system of expenditure of good i in region r
$\varepsilon^{r}_{(j)}$	Parameter: sensitivity of capital growth to rates of return of sector j in region r
$\eta^{r}_{(is)}$	Parameter: elasticity of foreign demand for good i exported by region r
$\theta^{(u)r}_{(is)}$	Parameter: economy of scale in the transport of good (i) produced in region s sent to user (u) in region r
$\mu^{(u)r}_{(i\cdot)}$	Parameter: returns to scale for primary factors ($i = g+1$ and $u = 1j$); or otherwise, $\mu^{(u)r}_{(i\cdot)} = 1$
$B\,(i, s, (u), r)$	Input-output flow: basic values of (is) in use (u) in region r
$M\,(m, i, s, (u), r)$	Input-output flow: basic values of domestic good m used as margin to facilitate the flow from (is) to (u) in region r
$T\,(\tau, i, s, (u), r)$	Input-output flow: tax collection τ from the sale of (is) to (u) in region r
$V\,(i, s, (u), r)$	Input-output flow: purchasing value of good or factor i from source s used by (u) in region r
$Y\,(i, j, r)$	Input-output flow: basic value of domestic good i by sector j in region r
$Q^{r}_{(j)}$	Coefficient: ratio between gross and net rates 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 sectors
U	Set:$\{(3), (4), (5), (6), (kj)$ for $k = 1, 2$ and $j = 1, ..., h\}$
U*	Set:$\{(3), (kj)$ for $k = 1, 2$ and $j = 1, ..., h\}$
S	Set: $\{1, 2, ..., r+1\}$, $r+1$ is the number of regions (including foreign ones)
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