MIBRA-USP, an interregional applied general equilibrium model for the Brazilian economy

Casimiro Filho, Francisco and Rocha, Marcelo Theoto and Lima, Patrícia Verônica Pinheiro Sales and Miranda, Silvia Helena G. de and Guilhoto, Joaquim José Martins

Universidade de São Paulo

2002

MIBRA-USP, An Interregional Applied General Equilibrium Model for the Brazilian Economy

Francisco Casimiro Filho[1]
Marcelo Theoto Rocha[2]
Patricia Verônica Pinheiro Sales Lima[3]
Sílvia Helena G. de Miranda[4]
Joaquim J.M. Guilhoto[5]

Abstract

On the external side Brazil has experienced since the beginning of the 1990's an opening process of its economy in a world environment were there have been a wide process of block formation (European Union, Nafta, Mercosur, etc.), on the internal side the Brazilian Real Plan in 1994 has started a period o relative stabilization in the economy that after more than two decades of high inflation has finally brought it under control. The above factors seem to have contributed to structural changes in Brazilian economy. These structural changes were not equally distributed among the sectors and the regions in the Brazilian economy. As an instrument that can be used to evaluate the impact of the economic policies over the regional development in the Brazilian economy, this work presents an interregional Applied General Equilibrium (AGE) model, MIBRA-USP, constructed for the 16 most important sectors in the economy as well as for the 5 Brazilian macro-regions (North, Northeast, Central West, Southeast, and South), calibrated for the year of 1995. This model follows in the tradition of the MONASH-MRF (Multiregional Multisectoral Model of Australian Economy) constructed for the Australian economy and as such the model is solved using the GEMPACK software and their solutions are giving in growth rates. This model is a development over two other previous AGE models, in the Australian tradition, constructed for the Brazilian economy: a) the PAPA model (Guilhoto, 1995) that is a national model with a data base in 1980; and b) the B-MARIA model (Haddad, 1998), an interregional model consisting of 3 regions (North, Northeast, and Rest of the Economy) and calibrated for 1985. The simulations conducted with the MIBRA-USP model were chosen in a way to study how the regions and sectors in the Brazilian economy would react to different sets of economic policies.

Key-words: Economic policies, Applied General Equilibrium (AGE) Model

[1] Department of Economy, Administration and Sociology - ESALQ – USP – fcasimir@esalq.usp.br
[2] Center of Advanced Studies on Applied Economy – ESALQ – USP – matrocha@esalq.usp.br
[3] Department of Economy, Administration and Sociology - ESALQ – USP
[4] São Paulo Agricutural Federation - de@faespsenar.com.br
[5] Department of Economy, Administration and Sociology - ESALQ – USP, and Regional Economics Applications Laboratory (REAL), University of Illinois – guilhoto@usp.br

Introduction

The Brazilian Economy has changed throughout the 1990´s, but there is still a long way until the country can reaches the growth rates and the international productivity already being observed in the rest of the world. The economic stabilization plans adopted by the government during the 1990´s were use to direct the country towards modernity, but there is still a need for an effective adoption of structural adjustment in the tax collection system as well as in the social security system.

According to Silva et al. (1993), economic stabilization plans, which main objective was inflation control, have begun with the "Cruzado" Plan in February 1986. At that time the inflation had surpassed the monthly rate of 16%. The expected success was not reached, generating other economic plans: a) Bresser plan (June/1987); b) Summer plan (January/1989); c) Collor I plan (March/1990); and d) Collor II plan (February/1991).

Since the successive economic plans had failed, the government adopted an orthodox position, just trying to avoid strong price increases. On July 1st, 1994, the Real plan was launched. Together with this Plan was implanted a Program of Immediate Action (PAI) that was successful in decreasing budget expenditures and in the conduction of the internal and external debts agreements.

Through the use of interest rates and exchange rates controls and trade liberalization policies, the government was successful in getting the prices stabilization in the early months of the Real plan implementation, and at the same time there was a growth in the GDP and an improvement in the trade balance. Some time after the Real plan have being implemented it was verified a currency valorization, as a result of the great capital inflows attracted by the high internal interest rates and, as a consequence, after a long time period of surplus in the external trade balance, the first deficit was verified in November of 1994.

Because of the trade liberalization and the exchange valorization, the imports raised, especially of capital goods, in this way avoiding growth rates in the economy that could lead to a rise in prices. This situation led to monthly average deficits of US$ 1,076 million in the trade balance, pressing the government to make changes in the economic policy (increase in the interest rates and a more restrictive credit policy). This caused a deep decrease in industrial production and investment (these ones had been increasing since 1993). In São Paulo State, the main economic State in Brazil, the employment level and real wage were reduced, respectively, by 10% and 6,4%, between April 1995 and March 1996.

The economic slow down, the devaluation in the exchange rate and an increase in import tariffs help to reduce the trade balance deficit. There was an increase in the monthly export average from US$ 3,7 billions on the second semester of 1995 to US$ 4 billions on the first semester of 1996. The possibility of higher growth rates for exports, as an induction factor for growth recuperation, is being considered still nowadays and it is also associated with the public deficit reduction through specific policy adoption.

Brazil presents large social and economic differences across its several regions and sectors, which makes more difficult the comprehension and elaboration of policies able to increase the economic growth and development. In this sense, this paper objective is to present an interregional and multi-sector model for Brazil, the MIBRA-USP. An interregional model was chosen because, according to Haddad and Hewings (1999), Brazilian Economy "is not homogeneous internally, presenting strong variations across regions, sectors and income groups". Besides, it is important to point out that the Real Plan implementation was not directed to the regional development features of the country, but with focus in the stabilization prices, what turns the post-Real time context much more curious for its general effects assessment over the economy.

The Brazilian Macro Regions

According to the classification of Brazilian Institute of Geography and Statistics (IBGE) the Brazilian Economy is divided into 5 macro regions, see Figure 1: a) North (7 States); b) Northeast (9 States); c) Central West (3 States and the Federal District); d) Southeast (4 States); and e) South (3 States).

The overall size of the Brazilian territory is 8,511,996 Km^2 of which 45.25% belongs to the North region, 18.25% to the Northeast, 18.85% to the Central West, 10.85% to the Southeast, and 6.76% to the South. However the economic and population distribution do not follow the geographical distribution, as can be seen in Table 1.

Figure 1- Map of Brazil and Its 5 Macro Regions

Table 1 - Main Economical and Geographical Characteristics of the Brazilian Macro Regions

	Size		Population (1996)		Urban Population	GDP 1995
	km^2	Share (%)	Number (1,000)	Share	%	Share (%)
North	3,851,560	45.25	11,288	7.19	62.36	5.27
Northeast	1,556,001	18.28	44,767	28.50	65.21	13.62
Central West	1,604,852	18.85	10,501	6.69	84.42	7.25
Southeast	924,266	10.85	67,001	42.66	89.29	56.97
South	575,316	6.76	23,514	14.97	77.22	16.89
Brazil	8,511,996	100.00	157,070	100.00	78.36	100.00

Source: IBGE (1997a and 1997b), Considera and Medina (1998).

Having 45.25% of the Brazilian territory the North region has only 7.19% of the Brazilian population and the smallest number peoples living per km^2, it also has the smallest share of population living in the cities (62.36%) and the smallest share in the Brazilian GDP (5.27%). The most developed regions in Brazil are the Southeast and the South region. The Southeast region has a share of 56.97% of the Brazilian GDP with 42.66% of its population and 10.85% of the territory, while the South region has a share of 16.89% in the Brazilian GDP with 6.76% of the territory and 14.97% of the population. The Southeast region is the most industrialized region in Brazil, while the South region is the one more closed to the Mercosur countries, which is the region that due to the continental size of Brazil could be the one to get the most benefits from the Mercosur integration. The Central West region has been an important region for Brazil in terms of agriculture, mainly because of the favorable type of land that this region has, an it has a reflex in its share in the population (6.69%) and GDP (7.25%) of Brazil. The Northeast region has serious problems of draught and in the beginning of the formation of the Brazilian State it used to be it most important region, this region has 18.28% of the Brazilian territory, 28.50% of its population and 13.62% of its GDP, recently oil extraction and processing has been one of the most growing business in the region and with the openness of the Brazilian economy a lot of industries have been installing they production units in the region (in part due to the fiscal incentives giving by the various levels of the state).

Methodological Reference

Regional modeling has gone through a lot of changes in the last decades, starting with the Input-Output (I-O) era, when the main concern was related to the regional economy data integrity, passing by the social accounts matrices construction methods and demo-economic models, to the current integrated models (in general I-O and econometrics) and those of computable general equilibrium models which take the regional I-O like a core component for the modeling (West and Jensen, 1997).

The Computable General Equilibrium Models, based upon the Walrasian general equilibrium theory, have added substitutability, price-effects and flows equilibrium to the traditional I-O models (Najberg et al., 1995).

The Applied General Equilibrium (AGE) Models can be applied to a region or a group of regions. The B-Maria Model (Haddad, 1998) was the first interregional AGE model applied to the Brazilian

economy, and it is based on the MONASH-MRF model constructed for the Australian Economy, which in turn follows the ORANI-F model, a national model of the Australian Economy.

Some trends may be mentioned related to the recent evolution of interregional general equilibrium models in other countries. Isard et al. (1998) has made a survey of these works. They comment about Bröcker (1995) paper that criticizes the CES function adoption, considering doubtful its use for composite goods definition like inputs or products consumed by families. The authors also stress that this paper has introduced a monopolistic competition approach in order to recognize the good diversity, thus incorporating a market imperfection factor consisting in a meaningful advance in those models evolution.

Isard et al. (1998) explain about the requirements over the searches related to a better elaboration of economies of scale questions, what is considered as a determinant factor to the entrepreneurial behavior, particularly on the transport sector. They comment that the studies of Jones and Whalley (1989), Walley and Trela (1989) and Elbers (1992) have tried to incorporate in a more efficiently way the transport issue on the economy. According to this author, Ando and Shibata (1997) and Ando (1996) have tried to build an interregional model for China and they also recognized the transport relevance to the development of different regions, as well as the freight costs importance for price determination in these regions.

Basically the general equilibrium models admit the evaluation of macroeconomics policies impacts with effects on regional development using simulation of these policies. Haddad (1998) gives examples of the utility of interregional models in the impacts of tariff barriers elimination effects; taxes policies and others evaluations.

Najberg et al. (1995) present examples of papers that have applied AGE models to verify the impact of economic policies on the economy. They mentioned Adelman and Robinson (1978) who investigated the implications of different growth strategies over income distribution for South Korea. They also mentioned that the AGE models were used to analyze the restriction effects of Balance of Payment over production structure and over the foreign trade of developing countries.

The above authors studied a real devaluation of exchange rate on the current transaction of Balance of Payment and an increase in the imports tariffs to explain the potential capability of those AGE models to measure impacts of economic policy changes. They concluded that those models are useful to give a direction in choosing the instruments of economic policy and to evaluate the Economy answers to external

shocks, i.e., to give subsidies for analysis involving the efficient resources allocation. Trade liberalizing impacts, as well as sector investments reallocation, fiscal adjustments and structural reforms on production, employment and foreign trade can be investigated through the present approach, because of the flexibility to admit several sectors desegregation, production factors and regions desegregation.

Another relevant application of interregional models is for migration studies and, especially labors mobility. According to West and Jensen (1997), the regional market effective independence degree issue and the interregional relationship across those markets have not yet been conveniently studied and it is not possible to make final conclusions at this moment. A more proper and possible conclusion discussed is that independent markets in relation to the price determination seems not exist, and the national pressures seems to be the dominant power in the labor regional markets, although these ones are well defined.

Haddad and Hewing (1999) applied the B-Maria to make comparisons of expected answers to economic policies shocks in the short and long run. Peter (1997) proposed static-comparative closures to the MONASH-MRF. For the short run, in the supply side, it can be assumed that regional population and labor supply, regional wages differentials and national real wage are all held fixed on a pre-defined level. According to him, the assumptions about wage rates are enough to the regional employment determination by the model application. Regional unemployment rates are free to vary according to changes in regional employment. Fixing the national real wage means that the nominal wage rate is indexed to the national consumer price index.

The above model also admits long run closures. By the supply side, in labor market, shocks are assumed not to affect the aggregate employment. In the long run, aggregate employment is determined by demography variables, labor share rates and the by the natural employment rate. Long run shocks can affect the regional employment distribution, but not the national one. In the long run, capital reallocation effects are admitted. About land and technology assumptions, they are the same of short run ones.

Peter et al (1996) discussing the MONASH-MRF, points out that a feature that distinguishes the short and long run approaches is the industry capital treatment. Short run simulations suppose fixed capital stocks.

A results static-comparative interpretation for MONASH-MRF suits for political analysis. Though the Government planners and the entrepreneurs need production, prices and other variable forecasts to subsidize their investment decision (Peter et al., 1996).

Preparing the MONASH-MRF model to the objectives of this paper

West e Jensen (1997) do not consider that MONASH is a "true" regional model, since the impacts are national and then spilled among the regions, not allowing to measure the specific impacts over the regions. There are variants of the MONASH model, includes some State models (only one region) and inter-states (multi-regions), like MONASH-MRF, already mentioned.

In common with the conventional AGE models, in the MONASH-MRF the demand and supply curves of products, capital and labor, are determinate by the optimum behavior of agents in the market. In this model, each regional economy had a treatment similar to the treatment of a unique region in the MONASH model, but considering the inter-regional linkages.

The multi-regional forecast model, MONASH-MRF, is an AGE regional model of the Australian economy. The model recognizes eight regions, including the six States and two Territories.

The model's equations are presented in five modules:

- The AGE core module
- The government finance module
- The capital and investment module
- The debt accumulation module
- The labor market & regional migration module

The AGE core module consists of the equations and variables of the original ORANI model with a regional subscript added (see Dixon, Parmenter, Sutton and Vincent (DPSV), 1982 for the original version of ORANI). This module is separated into four main equation blocks determining: (a) consumer demands (b) producer and consumer prices (c) market clearing conditions (d) macroeconomic variables as summations of microeconomic variables.

The government finance module incorporates equations determining: a) gross products of each region from the income and expenditure sides; and, b) sources of income and various expenditure accounts for regional and federal governments as defined in the State Finance Statistics of the Australian Bureau of Statistics (ABS).

The capital & investment and debt accumulation modules are added to make endogenous: (a) changes in total investment and capital stock over a forecast period; and, (b) the accumulation of foreign

debt. The capital accumulation section of the capital & investment module is based on one of three alternative treatments implemented in the MONASH model. The entire debt accumulation module is based on ORANI-F (see Horridge, Parmenter and Pearson, 1993).

The labor market & regional migration module defines equations determining regional population by taking into account: a) natural growth; b) inter-regional migration; and, c) foreign migration. Regional labor supply is linked to regional population via accounting identities that allow for shifts in the relationship between regional population and the regional population of working age and the workforce-participation rate. The module also includes equations defining changes in regional unemployment rates.

The choice of the model used in this paper is based on some evidence, like Peter et al. (1996) that argue that the equation system of MONASH-MRF presented in a linear form (percentage changes) have some economic and computational advantages. The linear systems are easily resolved, what allow more complex models, with thousands of equations. Moreover, the size of the model can be reduced with substitution of secondary variables.

MIBRA-USP: general characterization and proposals

MIBRA-USP is an interregional and multi-sector model. Belongs to the Johansen-Orani class of models, with the structural equations in a linear form (percentage changes) and the results in growth rates. It is based on the MONASH-MRF model, using in this first stage of development only the AGE core module.

MIBRA-USP is the first interregional AGE model constructed for all the five Brazilian macro regions. One of the goals in constructing the model is such that it can be used to give subsidies for political and economic interregional planning.

The B-Maria model, divided Brazil in 3 main regions: North, Northeast and Central-South (rest of Brazil). MIBRA-USP has the difference of working with five regions, with is very important since there are clearly economic and social differences among the Brazilian regions. The data base year for the B-Maria model is 1985 while for the MIBRA-USP it is for 1995.

The supply and demand curves of products are determined by the optimum behavior of the agents in the competitive market. This optimum behavior also determines the demand curves of labor and capital. The decision of production and consume are functions of prices variations, so the equilibrium is a Walrasian type.

In the model, each sector has only one product and produce only one type of capital, with only one class of work. There are two margins: transportation and commerce. The margins are very important variables, specially the transportation margin, since they allow very detail analyses of the impact of the infrastructure over the others sectors of the economy.

The results are based in a *bottom-up* approach, but there are situations for the use of a hybrid model (with the *top-down* approach). The first approach allows the aggregation of regional results in national ones. This approach make easy the analyze of regional polices, but demand a bigger database, since its necessary to make the specification of the regional flows.

For the model construction, the I-O matrix of 1995 was used as database. The sectors and industries used are presented into Table 2. The agents of the model are: a) industries; b) households (one household for each region); c) government (only one); and , d) exports.

Table 2 - Sectors in the MIBRA-USP model

N.	Sectors
1	Agriculture
2	Mining and Non-metallic minerals
3	Metallurgy
4	Mechanics
5	Electronic material
6	Transportation material
7	Wood, Furniture, Cellulose, Paper and Graphical
8	Chemistry and Druggist
9	Textile, Clothes and Footwear
10	Food and Beverage
11	Others industries
12	Communications
13	Civil construction
14	Commerce
15	Transportation
16	Services

Figure 2 shows the structure of the model, an absorption matrix where the rows are the products bought by the agents, identified in the columns. The model takes into account six regions of product source: a) North; b) Northeast; c) Center West; d) Southeast; e) South; and f) imports. The first five regions are also destiny regions.

Figure 2 – MIBRA-USP absorption matrix

			1					2					3					4	5				
			Production					Investment					Consume					X	Goverment				
			N	NE	CO	SE	S	N	NE	CO	SE	S	N	NE	CO	SE	S		N	NE	CO	SE	S
		Size	16	16	16	16	16	16	16	16	16	16	1	1	1	1	1	1	1	1	1	1	1
INPUTS	N	16	**BAS1**					**BAS2**					**BAS3**					**BAS4**	**BAS5**				
	NE	16																					
	CW	16																					
	SE	16																					
	S	16																					
	I	16																					
MARGINS	N	16	**MAR1**					**MAR2**					**MAR3**					**MAR4**	**MAR5**				
	NE	16																					
	CW	16																					
	SE	16																					
	S	16																					
	I	16																					
	N	16																					
	NE	16																					
	CW	16																					
	SE	16																					
	S	16																					
	I	16																					
TAXES	N	16	**TAX1**					**TAX2**					**TAX3**					**TAX4**	**TAX5**				
	NE	16																					
	CW	16																					
	SE	16																					
	S	16																					
	I	16																					
W		1	**LABR**																				
K		1	**CPTL**																				
L		1	**LAND**																				
O		1	**OCTS**																				

I – Number of commodities – 16
J – Number of industries– 16
M – Number of labour classes - 1
Q – Number of regions – 5
R – Number of commodities used as margin - 2
S – 6: 5 regions + 1 importation
X – exportation 1

W - labour
K - capital
L - land
O – other costs

Table 3 shows the elasticity's and parameters of MONASH-MRF model, which were used in the MIBRA-USP model. The values of these coefficients came from Guilhoto (1995). The Frisch parameters were calculated using the work by Lluch and Williams (1977). In the estimation of these parameters the regional GDP of Silva and Medina (1999) was used.

Table 3 – Model elasticity's

Coefficients	Index	Number of Coefficients	Description
σ^{1}_{ijq}	i = 1, ..., g j = 1, ..., h q = 1, ... , 5	5gh	Elasticity of substitution between regional source of good i, used as input in of industry production j in region q
σ^{1*}_{ijq}	i = 1, ..., g j = 1, ..., h q = 1, ... , 5	5gh	Elasticity of substitution between domestic and foreign source of good i, used as input in of industry production j in region q
σL^{1}_{jmq}	j = 1, ..., h m = 1 q = 1, ... , 5	5hm	Elasticity of substitution of employment m, used as input in of industry production j in region q
σF^{1}_{vjq}	v = 1, 2, 3 j = 1, ..., h q = 1, ... , 5	15h	Elasticity of substitution between primary factor v and others primary factors used as input in of industry production j in region q
σ^{2}_{ijq}	i = 1, ..., g j = 1, ..., h q = 1, ... , 5	5gh	Elasticity of substitution between regional source of good i, used as input in capital creation of industry j in region q
σ^{2*}_{ijq}	i = 1, ..., g j = 1, ..., h q = 1, ... , 5	5gh	Elasticity of substitution between domestic and foreign source of good i, used as input in capital creation of industry j in region q
σ^{3}_{iq}	i = 1, ..., g q = 1, ... , 5	5q	Elasticity of substitution between regional sources of good I, consumed by families, in region q
σ^{3*}_{iq}	i = 1, ..., g q = 1, ... , 5	5q	Elasticity of substitution between domestic and foreign source of good i, consumed by families, in region q
ε_{I}	i = 1, ... , g	g	Price elasticity of export demand of good I
η_{ikq}	i = 1, ..., g k = 1, ..., g q = 1, ... , 5	g^2q	Cross price elasticity of families demand and region q, for the good i, with relation with the price of the good k.

Notes:
1 Industry production
2 Capital
3 Family demands
i Input
j Sectors (16)
q Regions (5)
v Primary factors
d Income groups

The equations of the model are divided in the following groups:

- Demands by industries for intermediate inputs-User 1
- Primary factor demands, prices and supplies
- Demands by industries for capital creation, User 2
- Household demands for commodities, User 3
- Tax rates
- Purchasers' prices of commodities
- Tax revenues
- Demands for exports
- Demands for commodities for regional Other expenditure
- Margin usage of commodities
- Supply equals demand for domestic & imported commodities
- Basic prices
- Components of regional GDP, real and nominal
- National GDP, real and nominal and its components
- Regional and national price indices
- Money wage settings
- Miscellaneous definitions of factor prices
- Employment Aggregates

The model closure

With the objective of reduce the equation numbers some variables were omitted or substituted (Table 4). The final result is a system with 20.915 equations and 22.467 unknown variables, becoming necessary then the choice of 1.552 exogenous variables (Table 5).

Table 4 – Omissions and substitutions of the model

Variables	Description	Condition
a1	All Input augmenting technical change	Omitted
a1land	Land augmenting technical change	Omitted
a1oct	"Other Cost" ticket technical change	Omitted
a2ind	Neutral tech change, cap. Creation	Omitted
deltax1all	Overall percent-point change in indirect tax rates, user 1	Omitted
deltax2all	Overall percent-point change in indirect tax rates, user 2	Omitted
deltax3all	Overall percent-point change in indirect tax rates, user 3	Omitted
deltax5all	Overall percent-point change in indirect tax rates, user 5	Omitted
deltaxdest	Reg. tax shifter (percentage-point change)	Omitted
fep	Price (upward) shift in export demands	Omitted
feq	Quantity (right) shift in export demands	Omitted
a3sub	Changes in household taste subsist	Substituted
a3lux	Change in household tastes, luxury	Substituted
p1c	Prices of composite inputs for current production	Substituted
x1c	Demands for inputs for current production	Substituted
p2c	Prices of composite inputs for capital creation	Substituted
x2c	Demands for inputs for capital creation	Substituted
p3c	Prices of composite inputs for households	Substituted
x3c	Demands for inputs for households	Substituted
p1a	Prices of inputs for current production	Substituted
deltax1	Percent-point change in tax rate on sales of inter. Inputs	Substituted
p2a	Prices of inputs for capital creation	Substituted
deltax2	Percent-point change in tax rate on sales for cap. creat.	Substituted
p3a	Purchasers prices by commodities and source for households	Substituted
deltax3	Percent-point change in tax rate on sales to households	Substituted
p4r	F.O.B. for currency export prices	Substituted
p5a	Purchasers' prices for commodities (by source) by "Other"	Substituted
deltax5	Percent-point change: tax rate on sales to reg. Other demand	Substituted
x1o	Demands for inputs for current production	Substituted
x2o	Demands for inputs for capital creation	Substituted
x3o	Demands for inputs for households	Substituted
x1marg	Margins - current production	Substituted
x2marg	Margins - capital creation	Substituted
x3marg	Margins - on sales to households	Substituted
x4marg	Margins - on exports	Substituted
x5marg	Margins - regional "Other"	Substituted
efflab	Effective labor input	Substituted
x1laboi	Employment of occupation type m in industry j	Substituted
utility	Utility per household	Substituted
export	Foreign currency value of exports	Substituted
imp	Foreign currency value of imports	Substituted
ir	Aggregate real investment expenditure	Substituted
xi3	Consumer price index	Substituted
xi2	Investment price index	Substituted
x5a	Regional "Other" demands	Substituted

Table 5 – Exogenous variables of the model

Variables	Description
All 1 components of 'natfep'	Economy-wide shifter of export demand curves
All 1 components of 'natphi'	Exchange rate
All 16 components of 'natx0imp'	Import volumes
All 16 components of 'naty'	Capital creation by using industry
All 5 components of 'aggnt_feq'	Quant. shift non-trad. Exports
All 5 components of 'aggnt_fep'	Price shift non-trad. Exports
All 6 components of 'deltaxsource'	Reg. tax shifter (percentage-point change)
All 12 components of 'faggnt_i'	Shifter by commodity
All 5 components of 'faggnt_s'	Shifter by region
All 5 components of 'faggnt_p4r'	Shifter on agg price by region
All 5 components of 'fwage'	Overall real wage shifter
All 5 components of 'f5gen'	Overall shift term for regional "Other" demands
All 5 components of 'luxexp'	Total supernumerary household expenditure
All 5 components of 'octrev'	Aggregate other cost ticket payments
All 5 components of 'qhous'	Number of households
All 5 components of 'xiy_r'	Regional GDP deflator
All 5 components of 'xsimp'	Imports vol. in inter-regional trade
All 80 components of 'a1cap'	Capital augmenting tech. Change
All 80 components of 'a1lab'	Labor augmenting technical change
All 80 components of 'a1prim'	All prim. factor technical change
All 80 components of 'a3com'	Change in household tastes
All 80 components of 'arpri'	Payroll tax adjustment factor
All 80 components of 'curcap'	Current capital stock
All 16 components of 'deltax'	Percentage-point change in the general sales tax rate
All 60 components of 'faggnt_is'	Shifter by commodity & region
All 80 components of 'f1oct'	Shifters, "Other Cost" tickets
All 80 components of 'fwagei'	Industry-specific wage shifter
Just 73 of the 80 components of 'pi'	Costs of units of capital
All 16 components of 'powtaxm'	Power of tariffs
All 80 components of 'r0'	Current rates of return on capital
All 80 components of 'xi_fac'	Index of factor costs
All 480 components of 'f5a'	Shift in regional "Other" demands

Preliminary results

To test the closure, a shock in the exchange rate (natphi) of 10% was made, meaning a devaluation of 10%. The solutions were obtained using the Johansen and Gragg methods. Table 6 shows the results from the principal's macro-economic aggregate variables. In Table 7 we have the impacts in each region over the foreign terms of trade, and Table 8 shows the impacts on the CIF foreign currency import prices.

Table 6 – Impacts in the principal's macro-economic aggregate variables (%) resulted from a devaluation of 10% in the exchange rate.

Variable	Description	Johansen	Gragg
deltax4all	Overall percent-point change in indirect tax rates, user 4	10.94	11.11
natc	Nominal total household consumption	0	-0.13
natdelB	Ordinary change in balance of trade	5939.54	4397.69
natexport	Foreign-currency value of exports	0.8	0.06
natexpvol	Export volumes	0.62	-0.29
natimp	Foreign currency value of imports	-10	-9.09
natimpvol	Import volumes	0	0
natin	Aggregate nominal investment	0	0
natiR	Aggregate real investment expenditure	0	0
natkT	Aggregate capital stock, rental weights	0	0
natl	Aggregate employment, wage bill weights	1.23	3.96
natlabrev	Aggregate payments to labour	0.62	1.16
natoctrev	Aggregate other cost ticket payments	0	0
natothreal5	Aggregate real regional "Other" demands	1.33	0.87
natpwage	Aggregate nominal wages to workers	-0.62	-2.8
nattot	Economy-wide terms of trade	10.18	10.39
natxi2	Investment price index	0	0
natxi3	Consumer price index	0	0
natxi4	Exports price index	10.18	10.39
natxi5	Regional "Other" demands price index	0	0
natxigdp	GDP price index, expenditure side	0.81	0.81
natxim	Imports price index	0	0
natxiplpk	Relative prices of labour and capita	-0.69	-3.02
natz_tot	Aggregate Output: Value-Added Weights	0.4	0.28

Table 7 – Impacts in the foreign terms of trade (%) resulted from a devaluation of 10% in the exchange rate.

Region	Johansen	Gragg
North	10.27	11.51
Northeast	9.78	9.98
Central West	10.09	10.26
Southeast	10.24	10.41
South	10.13	10.33

Table 8 – Impacts in the CIF foreign currency import prices (%) resulted from a devaluation of 10% in the exchange rate.

Sector	Johansen	Gragg
Agriculture	-10	-9.090909
Mining and Non-metallic minerals	-10.000001	-9.090909
Metallurgy	-10	-9.090909
Mechanics	-10	-9.090909
Electronic material	-10	-9.090909
Transportation material	-10	-9.090909
Wood, Furniture, Cellulose, Paper and Graphical	-10	-9.090909
Chemistry and Druggist	-10	-9.090909
Textile, Clothes and Footwear	-10.000002	-9.090899
Food and Beverage	-10	-9.090911
Others industries	-9.999999	-9.090909
Communications	-9.999999	-9.090913
Civil construction	-10	-9.090909
Commerce	-10	-9.090909
Transportation	-10	-9.090909
Services	-10	-9.090909

The results most be seeing as preliminary ones due to the fact that the model is under development and inconsistencies still do appear on it. In Table 9, the use of different solution methods, Johansen and Gragg, show contrary results for some regions (North, Southeast and South).

Table 9 – Impacts in export volume (%) resulted from a devaluation of 10% in the exchange rate.

Region/Solution method	Gragg	Johansen
North	2.77	-3.53
Northeast	0.65	2.29
Central West	0.69	1.62
Southeast	-0.23	0.7
South	-1.29	0.3

Conclusions

Brazil presents large social and economic differences across its several regions and sectors, which makes more difficult the comprehension and elaboration of policies able to retake the economic growth and development. In this sense, this paper objective is to propose an interregional and multi-sector model for Brazil, the MIBRA-USP. The preliminary results show that the model can be used in helping the choice of economic policies that will led to growth and development of Brazil and its regions, however the model is still in under construction and its preliminary results should be taken with care.

This inconsistencies can result from several factors: a) the quality of data base; b) the elasticity's estimation; c) the equation system; and d) the set of exogenous variables used in the closure.

To test the existence or not of inconsistencies in the model several tests can be used, like the homogeneity test (Harrison & Pearce, 1998). Also there is a need for improvements in the input-output database and in the set of elasticity's. The MIBRA-USP can also benefit, in a second stage, from a better adaptation of the equation system to the Brazilian economic reality and from the inclusion of the modules of MONASH-MRF left out from the system.

We do hope that in the future MIBRA-USP will became a tool that can be used to better understand the Brazilian economy and its regional problems as well as to be used as an instrument to measure the impacts of macro-economic policies over the nation and is regions, contributing in this way for a better economic development of Brazil.

References

Baer, W. A Economia Brasileira. Ed. Nobel. 1995. 416p.

Considera, C.M. and Medina, M.H.(1998). "PIB por unidade da federação: valores correntes e constantes – 1985/96". *Texto para Discussão, 610*. IPEA . Rio de Janeiro. December.

Guilhoto, J.J.M. Um modelo computável de equilíbrio geral para planejamento e análise de políticas agrícolas (PAPA) na economia Brasileira. Piracicaba, 1995. 258p. Tese (Livre-Docência) - Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo.

IBGE (1997a). *Anuário Estatístico do Brasil 1996*, v. 56. Rio de Janeiro.

IBGE (1997b). *Contagem da população 1996*. Rio de Janeiro.

Isard, W.; Azis, I.J; Drennan, M.P.; Miller, R.E.; Saltzman, S.; Thorbecke, E. Methods of Interregional and Regional Analysis. Regional Science Studies Series. Ashgate. Aldershot, 1998. 490p.

Haddad, E.A. Regional inequality and strutuctural changes in the brazilian economy, 1998. 229p. Tese (Doutorado) – University of Illinois at Urbana-Champaign.

Haddad, E. A.; Hewings, G.J.D. The short-run regional effects of new investments and technological upgrade in the Brazilian automobile industry: an interregional computable general equilibrium analysis. *Oxford Development Studies*, v.27, n.3, 1999. p. 359-393.

Harrison, W.J.; Pearson K.R. GPD1 - An introduction to GEMAPCK. Centre of Policy and Impact Project, Monash University, 1998.

Harrison, W.J.; Pearson K.R. GPD2 - User's guide to Tablo, Gemsim and Tablo-generated programs. Centre of Policy and Impact Project, Monash University, 1994.

Harrison, W.J.; Pearson K.R. GPD3 - How to Create and Modify GEMPACK Header Array Files Using the Program MODHAR. Centre of Policy and Impact Project, Monash University, 1993.

Harrison, W.J.; Pearson K.R. GPD4 - Release 6.0 of GEMPACK - New Features and Changes from Release 5.1 and 5.2. Centre of Policy and Impact Project, Monash University, 1998.

Harrison, W.J.; Pearson K.R. GPD6 - Installing and Using the Source-code Version o fGEMPACK on DOS Windows PCs with Lahey Fortran. Centre of Policy and Impact Project, Monash University, 1997.

Harrison, W.J.; Pearson K.R. GPD7 - Installing and Using the Executable-image Version ofGEMPACK on DOS Windows PCs. Centre of Policy and Impact Project, Monash University, 1996.

Lluch, C.; Powell, A.A.; Willians, R.A. **Patterns in household demand and saving.** Oxford University Press, 1977.

Najberg, S.; Rigolon, F.J.Z.; Vieira, S. P.. Modelo de Equilíbrio Geral Computável como instrumento de política econômica: Uma análise de Câmbio x Tarifas - *Texto Para Discussão* nº 30. BNDES. Out/1995. 24p.

Naqvi, F.; Peter, M. W. Notes on the implementation of MONASH-MRF: a multiregional modelo of Australia. Centre of Policy Studies MONASH University. Working Paper nº OP-82, Apr./1995.

Peter, M. W. Notes on Comparative Static Closures for MONASH-MRF. MONASH University, Clayton. 01/08/97. 4p. Mimeo.

Peter, M.W.; Horridge, M.; Meagher, G. A.; Naqvi, F.; Parmenter, B.R. The theoretical structure of MONASH-MRF. Preliminary Working Paper, nº OP-85, Centre of Policy Studies – Monash University. Apr.1996. 121p.

Silva, A.B.O.; Medina, M.H. Porduto interno bruto por unidade da federação – 1985-1998. **Texto para discussão n. 677**. Brasília, 1999.

West, G.; Jensen, R. Regional economic modelling: some issues of use and validation. Paper presented at 15th PRSCO Meeting, Wellington, Dec. 1997. 21p. Mimeo.