

A Computable General Equilibrium Model to Analyze Distributive Aspects in Brazil with a Trade Policy Illustration

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Abstract: *This paper has been developed using a CGE modeling strategy for simulations of Brazilian trade policies that allows the analysis of income distribution impacts of macro shocks with complex and systemic propagation methods. In order to capture the distributive impacts, the model adopts a specific design focused on the separation of production and institutional factors, such as labor and households.*

The model is divided into three blocks: product market, factors market (essentially labor), and one block that handles income transfers among institutions. The labor market block incorporates a recent theoretical advance that allows the determination of involuntary unemployment in the equilibrium. The third block includes information on the distribution of the value added in the productive process among production factors, as well as its redistribution among agents/institutions considered in the model.

The simulations of a partial “closure” of the economy show a modest welfare reduction for most workers and their families. Also in this paper, we checked the homogeneity property of CGE Models and concluded that it can hold only with full indexation of all income transfers, which has important implications for the income distribution process.

Key Words: *Brazil, South America, CGE Model, Homogeneity, Trade Policy Evaluation, Welfare.*

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1. Introduction

This paper has been developed using a CGE modeling strategy that allows for the analysis of distributive impacts of macro shocks with complex and systemic propagation methods. In an attempt to capture distributive impacts, the model adopts a specific design focused on the separation of production factors (particularly labor) and institutional components such as households, firms and government levels. In addition, the paper demonstrates the operation of the model through various different simulations of Brazilian trade and external policies with a focus on the results related to employment and wages.

The model is divided into three blocks: product market, factors market (essentially labor), and one block about income transfers among institutions. The first block assumes a general neoclassical equilibrium for most markets in which the agents respond to relative prices as a result of the maximization of profits or utility by determining levels of production and consumption. This specification is very similar to one adopted by Devarajan *et al.* (1991), that has recently proven popular with CGE modelers.

The labor market block incorporates a recent theoretical advance that allows for the determination of involuntary unemployment in the equilibrium. Traditionally, CGE models follow the classical labor market story, in which jobs are available for everyone searching for employment. As this result does not seem to reflect the way the labor market operates in most countries¹, advances have been discussed in the literature and incorporated in our model.²

The third block includes information on the distribution of the value added in the productive process among the production factors, as well as its redistribution among agents/institutions considered in the model. The demonstration of these redistribution mechanisms was not present in Devarajan *et al.* (1991). Cury (1998) introduced these mechanisms that are also present in Barros *et al.* (2000a).

In the literature on the application of general equilibrium (computable general equilibrium models – CGE), the model used in this paper may be considered as the development of the “CGE-RH Approach”, in which the focus is on the disaggregated specification of the agents [Bourguignon *et al.* (2002)]. Moreover, the attention given to

¹ Blanchflower and Oswald (1990, 1994) present supporting evidence of this fact for 15 countries and also present a survey on other researches that found similar results.

² A more enhanced representation of the labor market in CGE may be found in Bovenberg *et al.* (2000).

transfer flows among institutions places the model in the direction of a “Tax Model”, focusing on the redistribute role of the public sector [Devarajan and Hossain (1998)].³

The paper is structured in seven sections. After this introduction, the following three sections demonstrate each one of the blocks discussed above. In the fifth section, an important attribute of CGE type models will be discussed showing the homogeneity of degree zero in prices; we describe the procedure adopted to guarantee the maintenance of this property in the model besides justifying the reason for this concern. Section six contains the description of the simulation results and section seven concludes the paper.

2. The Product Market

2.1. Product Supply

Foreign product supply is modeled as being totally elastic⁴, while domestic supply is represented in a more elaborated way, through a nested production function, which considers three types of inputs: labor, capital and intermediate inputs. This production function form is identical for all sectors and can be obtained in three stages.⁵

In the first step, the several types of existing labor (F_1) are aggregated in a group (Ld) for each sector (i), using for this purpose a Cobb-Douglas function with constant returns to scale.⁶ The labor types of the model are: 11-unskilled informal; 12-skilled informal; 13-formal with low skill; 14-formal with average skill; 15- formal with highly skilled; 16- low skilled public servant; 17- highly skilled public servant; which are aggregated in the following form:

$$Ld_i = \prod_1 F_{ii}^{\beta_i} \quad (1)$$

In the second step, aggregated labor (Ld) and capital (K) are associated using a constant elasticity of substitution (CES) function to obtain the sector i 's production values (X_i) such as:

$$X_i = a_i^D \left[\alpha_i Ld_i^{\rho_p} + (1 - \alpha_i) K_i^{\rho_p} \right]^{1/\rho_p} \quad (2)$$

³ Currently, there is a strong emphasis on the combined usage of different structures (Macro Models, CGE and Micro simulation). Barros *et al.* (2000a) applied the impacts of some variables of the CGE model to similar variables of a micro database for calculating poverty and inequality indicators in Brazil. For further discussion on this methodology, see Bourguignon *et al.* (2002).

⁴ In this sense, Brazilian demands for imported goods are fully satisfied without facing external supply constraints.

⁵ The model represents the 42 sectors of activities listed in the 1996 Brazilian National Accounts, whose tradable sectors are presented in the sixth section of the paper.

⁶ This means that an identical increase of every type of work results in an identical increase of aggregate work.

Finally, in the third step various intermediate inputs can be obtained, based on a Leontief production function (e.g., fixed proportion to total product):⁷

$$INT_i = \sum_j a_{ij} X_j \quad (3)$$

However, this output is not entirely offered to the domestic market. Producers react to the relative price of the domestic market *vis a vis* the international market. Thus, it is assumed that the producers do not specialize in only one market, i.e., the domestic production is totally divided with imperfect substitution among products sold to the domestic market and products destined for the outside market. The chosen functional form presents constant elasticity of transformation (CET) and assumes the following form the model:

$$X_i = a_i^T \left[\gamma_i E_i^{(\rho_i+1)/\rho_i} + (1-\gamma_i) D_i^{(\rho_i+1)/\rho_i} \right]^{(\rho_i+1)/\rho_i} \quad (4)$$

where X_i is total domestic production, E_i is the volume exported by sector i , and D_i is the domestic output of sector i sold in the internal market. a_i^T , and γ_i are parameters of the model and ρ_i is the elasticity of transformation.

2.2. Demand for products

Families

Families are classified into eight categories, according to per capita household income, level of urbanization and household head characteristics. The family types considered are: f1–poor urban families headed by active individual, f2–poor urban families headed by non-active individual, f3–poor rural families, f4–urban families with low average income, f5–urban families with average income, f6–rural families with average income, f7–families with high average income, f8–families with high income.

This separation yields more precision in the classification of the families by the degree of dependency to various sources of household income, including the remuneration of production factors, social security monetary benefits, and net income from financial assets.

As for the behavior of the families, we assume that they choose their consumption levels to maximize their utility subject to a budget constraint.⁸ In the current version of the

⁷ It is worth mentioning that Devarajan *et al.* (1991) makes use only of the first and third steps, by combining capital with labor and value added with intermediate inputs, in this order.

model, we use a Cobb-Douglas functional form (similar to the production function presented above), where goods available for consumption enter as arguments.

Goods demanded by families and firms, on the other hand, are not only those produced domestically, since these agents also demand imported goods. Following Armington (1969), we assume that goods are classified according to their source (domestic or external) and that consumers consider them as imperfect substitutes, while their utility is measured (in product quantity) by a function with a constant elasticity of substitution (CES) with the following form:

$$Q_i = a_i c \left[\delta_i M_i^{(\rho_{ic}-1)/\rho_{ic}} + (1-\delta_i) D_i^{(\rho_{ic}-1)/\rho_{ic}} \right]^{\rho_{ic}/(\rho_{ic}-1)} \quad (5)$$

where, M_i indicates the volume imported of good i , and D_i is the consumption of the domestic good i . $a_i c$ and δ_i are parameters and ρ_{ic} is the elasticity of substitution between D_i and M_i , whose values were taken from Tourinho *et al.* (2002), who estimated these elasticities for the same sectors considered in the model. Finally, Q_i is an indicator of the utility derived from the consumption of good i , but it also can be interpreted as a quantity of a hypothetical composite good, which adds imported and domestic goods. This composite good is what the consumers would demand.

There is also a demand for domestic goods in the international market where agents react to changes in relative prices as well. In a form analogous to that specified for import demand, the demand for exports arises from a CES utility function which represents the imperfect substitution between Brazilian products and products from the rest of the world.

Firms

Firms contribute in two ways for product demand. First, they meet their need of intermediate inputs necessary in the productive process. This demand is determined by the technical coefficients from the input-output matrix.

Due to the static nature of accumulation in the capital market, investments are important for product demand. As for the case of consumption, investment in our model is characterized as the purchase of certain goods. In this case, investment would be a type of final consumption undertaken by firms. Savings represent this amount of resources, and we assume that a share of it corresponds to investment in stocks of finished goods, while the remaining share corresponds

⁸ Actually, this utility maximization can happen along the consumers' lifetime. From the point of view of most

to the available amount required to purchase the final goods that must be used to expand production. The first share is defined based on a fixed proportion of the sector output. The second share is distributed exogenously among the different sectors, reflecting information from the input-output tables (goods by sector of origin) and the matrix of sectoral composition of capital (goods by sector of destination and origin).

Government

We assume that government consumption (GC) is derived from maximization of a Cobb-Douglas utility function subject to the budgetary restriction corresponding to the total expenditure that is fixed according with the total amount registered for the base year.

3. The Labor Market

As we have already seen, labor is modeled as a production factor used by firms. This factor is classified into 7 types, reflecting different forms of insertion in the labor market (contract status) and schooling.

We assume that the firms aim at maximizing profits taking the price of inputs, production factors and output as given. The firms also consider the technological constraints imposed by the production function specified before. Therefore, as a result of this maximization, the wages for each type of labor equalize their respective marginal productivity so that a demand curve for each type of labor is defined by:⁹

$$P_i \partial X_i / \partial F_{it} = W_{it} \quad (6)$$

As mentioned before, our alternative to incorporate involuntary unemployment in the equilibrium consists of interacting the demand for labor with the wage curve. This curve is a statistical regularity or empirical 'law' of economics originally reported by Blanchflower and Oswald (1990, 1994), that is described by a negatively-sloped curve linking the employees' wages to the unemployment rate in their region (or industry). The causality is thought to run

practical applications, the maximization is on the goods and services available in a given period.

⁹ The derivative of the profit function in relation to the demanded quantity of each factor must be equal to the factors' price (first order condition).

from the unemployment rate to wages and the curve emerged from microeconomic earnings equations estimation on large and comparable data sets for fifteen developed countries.¹⁰

The wage curve implemented in the model represents the negative relation between the unemployment rate (U_l) and the wage level (W_l) for the each type of labor l in Brazil, and that can be described by the following equation:¹¹

$$\ln W_l = \alpha_l - \beta_l \ln U_l \quad (7)$$

Blanchflower and Oswald (1994) also presents the theoretical foundations that justify the existence of wage rigidity, that is, basically efficiency wages or union bargaining. According to the first theory, the firm tends to motivate an efficient behavior by means of attractive wages. However, when the unemployment rate is high, the worker feels threatened of losing his job and tends to be naturally efficient and the firm does not need to offer an attractive wage. In an alternative way, firms may feel pressured to raise wages when unemployment is low, as the bargaining power of workers increases under this situation.

In sum, we can interpret the wage curve as a wage determination policy by the firms that takes into consideration competition among workers to occupy a job vacancy. When this competition is high (high unemployment rate), the firm can offer a relatively low wage. The sensitiveness of this movement is given by the parameter β , whose values were taken from Reis (2002) who presents their econometric estimations for Brazilian case.

The form in which the wage curve operates in the labor market equilibrium determination can be visualized in the figure below.¹² Point E represents the full employment equilibrium in a market affected only by supply (L^o) and demand (L^d). With the introduction of the wage curve (S), the equilibrium levels of employment and wages is determined by E' , the intersection point between the demand curve and the wage curve. The wage level defined by E' does not correspond to the labor supply, and the difference is the excess supply of labor that corresponds to the unemployment level in the economy.

¹⁰ The estimated curve held after controlling for workers' personal and demographic characteristics, for regional characteristics, and for macroeconomic and other aggregate influences, and presented very similar curvature of the function in each of the fifteen countries in which the curve has been found. Bhalotra (1993) and Hoddinot (1993), *apud* Blanchflower and Oswald (1994), found similar results for India and Cote d'Ivoire, respectively.

¹¹ Another specification of the wage curve that have already been incorporated to interregional CGE models. This specification captures the relationship between regional unemployment rates and regional wage levels. See the specification of the AMOS model, as presented by Ferguson *et al.* (2003).

¹² In order to represent the relation in axis L, W we must have in mind that $U = (L^o - L)/L^o$.

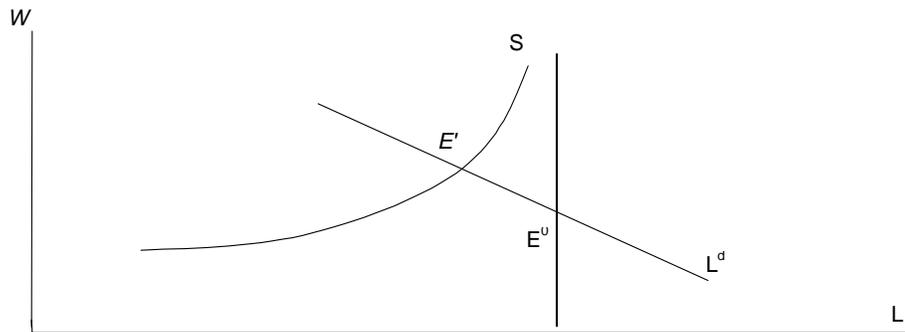


Figure 1- Equilibrium in the Labor Market for a Given Type of Labor

Note that the labor market closure is not formulated by sector, but rather by type of labor.¹³ Therefore, first, we have the definition of levels of employment, wages and unemployment for each type of labor in the aggregate for all sectors of the economy. To define the employment and wage levels in each sector, it is necessary to assume an additional behavioral rule in the labor market.

The labor market specification is complemented, therefore, by assuming that the wages of a given type of worker are differentiated by sector in the model which implies, in practical terms, in sectoral segmentation in the labor market (for example, a formal worker with average qualification from the mechanic/automobile sector receives a wage that is larger than the wage he/she would receive in the clothing sector).¹⁴ The mechanism used in this process is the inclusion of an exogenous variable for relative wage differentials among the sectors. Thus, from the average wage for each type of labor, we can determine the wage of workers in each sector. With this information, we can also determine the employment level of each type of labor in the different sectors.

4. The Mechanisms of Income Transfer

In this block of the model, we take into consideration the formation of income flows received by families, firms, government, and the rest of the world. This process encompasses

¹³ The same applies for labor supply.

¹⁴ The hypothesis implicit in this mechanism is that workers with similar observed productive characteristics are paid in a different way according with their sector of employment/occupation. Pinheiro and Ramos (1995) have not only proven this fact but also demonstrate that it is stable along the time.

two parts: the definition of the distribution of the value added in the productive process (primary income distribution) and the transfers among the mentioned agents (secondary income distribution).

The first share is constructed simply by attributing to firms the remuneration of capital and to workers the remuneration of labor. It is worth mentioning that the model considers two types of firms: small (self-employed people) and large (other firms). The large firms receive a large share of the remuneration of capital, while the small firms receive the remaining remuneration of capital. In each sector, the payments to capital are distributed to these firms according to the initial proportion of their earnings in the total payment.

The distribution of earnings of the seven types of labor to the eight types of families is made according to the initial distribution of these workers by families. The share of income of each type of workers that goes to family h is given by the proportion of this type of labor that is in this type of family (ε_{hl}). Families also receive the remuneration of capital transferred by firms (large and small), YK . The distribution among each type of family is given by the family h 's proportion in each of these income flows (matrix ε_{hk}).

Besides these remunerations, the net remittances from abroad (RE_h), adjusted by the exchange rate (R), and the share of transfers made by the government and directed to the families (TG), complete the determination of the household incomes. This last transfer is made in two alternative ways: as payment of benefits in the form of direct income transfers,¹⁵ and as other transfers from the government to families (essentially domestic debt interest). The sharing of these resources among the different types of families in the model is fixed according to the proportion observed in 1996 (θ_{ht} for the government transfers). Therefore, the income of the family h can be represented as follows:

$$Y_h = \varepsilon_{hl} W_l + \varepsilon_{hk} YK + pindex \theta_{ht} TG + R \cdot RE_h \quad (8)$$

Note that the government plays a very important role in the process of determination of secondary income. Besides the transfers to families mentioned above, the government also directs a share of its transfers to firms¹⁶ under the form of interests on the domestic debt and consumes products in the way described in the previous section. As in the case of families, the

¹⁵ These transfers include the social security benefits as well as other programs such as unemployment benefits, income transfer social programs and other cash benefits.

¹⁶ The same applies for labor supply.

sharing of government transfers by type of firms follows the proportions observed in the base year (θ_k). Finally, the government also transfers resources abroad (GE) and government expenditures can be represented as follows:

$$GG = \sum_i CG_i + pindex.(\theta_h + \theta_k)TG + R.GE \quad (9)$$

To meet all of the expenditures mentioned, the government relies on three types of collections. First, there are direct taxes levied on firms and families. This collection corresponds to a fraction of the income of these agents (ϕ_h and ϕ_k , respectively). There are also indirect taxes levied on domestic and imported goods. This levy is proportional to the amount produced (X) and imported (M). The government also receives transfers from abroad (gfbor). Finally, there is the balance of the social security system ($SOCBAL$).¹⁷ Thus, the Government total revenue is given by:

$$RG = \sum \phi_h \cdot Y_h + \sum \phi_k \cdot Y.K + \sum \xi_j \cdot X_i + \sum \kappa_i \cdot M + R.PR + SOCBAL \quad (10)$$

An eventual lack of government resources is defined as a government deficit that together with private savings (from firms and families) and foreign savings defines the amount of resources spent in the form of investments.

5. Checking the Homogeneity Hypothesis

Due to the particularities of this model that tries to explore the complex income flows among the institutions, the common property of homogeneity of degree zero in CGE models can no longer be valid if at least one transfer flow is not indexed by the price index. In practical terms, this property means that the real variables are immune to a homogeneous shock in prices.¹⁸

By intuition, this result arises from the fact that relative prices remain unchanged. As the reaction of agents in both markets (goods and factor) in this type of model is a function of

¹⁷ In fact, social security is treated as an agent apart from the Government in the model, not only because of the considerable amount of resources that it handles in Brazil, but also because of the contributions that it applies on either the company's income (here again in a different form), or on the installments of the added value of labor.

¹⁸ Gynsburch and Keyzer (1997) puts the theoretical issue on homogeneity in the following form: "In any problem of optimization involving producers and consumers, the substitution of vector p , the equilibrium price, by λp , with a λ scalar greater than zero, results in the nominal variation of the producers profit, but does not alter their decision; on the other hand, for consumers, both sides of the budget restriction are modified, without varying the set of possible options. Therefore, as the preferences are not modified, the optimal decision is not affected".

relative prices, there are no reasons to believe that agents will change their behavior after a shock that changes all prices in the same proportion.

Our model expands substantially the number of redistribute transactions. In that way, it is necessary to check the validity of the homogeneity restriction due to its importance for the interpretation of the results. From a theoretical point of view, the solution would be to index all income transfers with a general price index. Thus, from an operational point of view, we index the direct transfers of the government to the remaining resident people in the country with the model's price index, and with the nominal exchange rate all the income flows with the rest of the world.

Nevertheless, an empirical test is necessary, as the complexity of the operational details of our extensions could have yielded any deviations from the theoretical result. Thus, from an empirical point of view, the checking of this hypothesis is made through the change of a price that works as “numeraire” in the model. In our specific case, this simulation took the form of doubling the exchange rate and then checking the effects on prices and quantities.

Actually, the results of this simulation indicate that there was no change in the set of variables that represent quantities (see appendix 1). As for the prices, there was a complete duplication and, consequently, in all nominal magnitudes in the model.

Thus, we have opted for this model specification that attends the homogeneity property. The counterpart of this procedure is to assume that income flows that we have modeled are perfectly indexed; a phenomenon that may not occur in the real world due to information problems and/or distributive conflicts.

6. Simulating a Trade Policy Shock

The main exogenous variables, whose values are defined in practice by the Brazilian trade policy are the import tariffs. In 1990, the trade liberalization process was accelerated and so, in order to not simulate an arbitrary policy, we will simulate a partial “closure” of the Brazilian economy by imposing the 1990 import tariff levels.

The objective of this simulation is to evaluate which would be the distributive impacts in Brazil at 1996 (base year) if the economy present the tariff structure of 1990, which is presented in table 1 below. The simulation results can be interpreted as being the families' welfare changes in the absence of the trade liberalization process.

Sector	1990	1996
Agriculture and Livestock	5,9	7,3
Mineral Extraction	9,6	3,7
Coal and Oil Extraction	3,3	-
Non-Metallic Minerals	31,5	10,5
Siderurgy	14,5	7,8
Non-Iron Metallurgy	17,6	8,8
Other Metallurgic Products	34,8	15,9
Machines and Tractors	37,2	15,5
Electrical Material	44,1	17,2
Electronic Equipment	40,6	15,6
Automobiles, Trucks and Buses	78,7	52,4
Parts and Other Vehicles	37,4	16,1
Wood and Furniture	25,4	11,0
Paper and Publishing	23,6	10,3
Rubber	46,6	12,5
Chemical Elements	24,8	6,5
Oil Refinery	19,4	4,1
Other Chemical Products	21,8	7,8
Pharmaceuticals and Perfumes	31,5	8,0
Plastic Items	39,0	15,2
Textiles	31,8	16,3
Apparel	51,1	19,8
Shoes	29,6	15,3
Coffee Industry	28,9	12,0
Vegetal Products Processing	34,6	12,0
Animal Slaughter	19,7	9,2
Dairy Products	32,7	18,9
Sugar Industry	25,7	16,0
Vegetal Oils	16,6	8,4
Other Food Products	45,0	15,1
Miscellaneous Industries	41,6	13,5
Simple Average	30,5	13,0
Source: Kume et al. (2000)		

In relation to the role of these variables in the Brazilian trade policy, it is worth mentioning that this policy covers a range of instruments that goes beyond the tariffs. There is in Brazil a series of non-tariff barriers that might substantially affect the Brazilian trade flow.¹⁹

¹⁹ Among the non-taxable barriers that are historically more relevant, there are the imposition of quotas, the specification of minimum prices for imported products and the prior licensing, with complex bureaucratic procedures.

Before we comment on the results, it is worth mentioning how the simulations may affect the labor market indicators in our model. In general, the simulations affect the productive structure that, by its turn, affects the demand for the different types of workers. The transmission mechanisms present in these changes are shown in Box 1.

Box 1. Transmission Mechanisms of the Change in the Tariff on the Demand for Labor

↑ Tariff	↑ Demand for Domestic Goods (a)	↑ Labor Demand	
	(↑↓) Resources Available for the Government	↑↓ Government Consumption (b)	↑↓ Labor Demand
		↑↓ Private Consumption via Government Transfers (c)	
		↑↓ Investment via Government Savings (d)	

The simulation that involves only the tariffs, on one hand, results in consumers substituting imported goods by domestic goods. On the other hand, the external demand for domestic goods can fall due to possible valuation of the real exchange rate.

At the other source of demand, the government can either increase or decrease its revenue collections with the tariff rise, depending on the fall in consumption of imported goods *vis a vis* the larger tax levy per product. In this case, the government is forced to increase either its expenditures or its savings.

In this case, the demand for domestic goods would be altered. With changes in expenditures, government consumption and the level of transfers to families would also change. In the case of changes in savings, the amount available for savings would change, that in our model would mean a change in the demand for goods. Therefore, the effect on the demand for labor is unknown a priori.

The demand for each type of labor, by its turn, will also depend on which sectors have benefited the most from the import substitution and on which sectors have been affected the most by the change in government consumption or family transfers. Based on the information displayed in Box 1, we can say that the effect on labor demand depends on a combination of (a), (b), (c) and (d).

6.1. Results and Analysis of Tariff Simulation.

Table 2: Simulating an Import Tariff Rise					
Percentage Change in Employment					
	Total	Formal	informal	Skilled	Unskilled
Total	-0,405	-0,413	-0,577	-0,137	-0,536
Traditional Tradable	-2,240	-1,821	-2,713	-0,948	-2,407
Modern Tradable	0,357	0,330	0,485	0,173	0,414
Non-Tradable	0,117	-0,070	0,337	-0,090	1,594

Table 2, above, reports the reaction of the level and the structure of employment following our tariff shock simulation. The table reveals that the reaction to the import tariff rise would be a decline of less than 0.5% in total employment in the Brazilian economy. Although relatively small, this change points to a negative balance in the generation of employment, and as such, this result contradicts those who support policies that protect the domestic enterprises.

Concerning to the grouped sectors above, we notice that the negative effect on total employment is due to the decline of employment in traditional tradable sector (see the first column of the table). In our interpretation, with lower imports there will be a pressure to overvalue the exchange rate that will tend to make exports more expensive. The sectors in which exports are more sensitive to price changes are the most traditional ones. Thus, by exporting less, there would be a tendency for these sectors to produce less and, therefore, to employ less workers.

Regardless the economic sector and considering only the type of labor, the results are more homogeneous in the job contract dimension (type of insertion in the labor market), since both will tend to present modest reduction in the employment level. On the other hand, one can notice an employment reduction concentrated on the unskilled workers.

Table 3: Simulating an Import Tariff Rise							
Percentage Change in the Average Wage							
	Worker 1	Worker 2	Worker 3	Worker 4	Worker 5	Worker 6	Worker 7
Total	-0,673	-0,522	-0,483	-0,724	-0,007	-0,587	-0,76

Note: 11-unskilled informal; 12-skilled informal; 13-formal with low skill; 14-formal with average skill; 15- formal with highly skilled; 16- low skilled public servant; 17- highly skilled public servant.

As regards the wages, it is worth remembering that in our model the sectoral wage differentials are rigid. Thus, the wage structure can only react to the type of labor. As a consequence, we report in table 3 the changes in real wages for each type of worker without any sector desegregation. Note that the general effect is a real wage fall. In the formal and informal sectors, the main losers would be the less skilled workers. The formal high-skilled workers present a differentiated result since this type of workers does not seem to have their real wages affected, actually, becoming beneficiary of this policy and confirming the same type of behavior observed for the level of employment. The high reduction of public servants' remuneration is due to the fact that their employment levels are fixed in the model, thus, the total effect goes their salaries.

Table 4: Simulating an Import Tariff Rise							
Percentage Change in Household Income							
Family 1	Family 2	Family 3	Family 4	Family 5	Family 6	Family 7	Family 8
-0,512	-0,229	-0,452	-0,458	-0,478	-0,428	-0,5	-0,462

Note: **f1** – poor urban families headed by active individuals, **f2** – poor urban families headed by non-active individuals, **f3** – poor rural families, **f4** – urban families with low average income, **f5** – urban families with average income, **f6** – rural families with average income, **f7** – families with high average income, **f8** – families with high income.

Table 4 shows that all types of households have their incomes affected by the import tariff rise. The results show income falls that range between $-0,229$ (f_2 – poor household headed by an inactive member) and $-0,512$ (f_1 – poor urban household). These results demonstrate two factors: the least affected household is the one with a lower dependency on labor income, and the largest fall is observed for the poorest type of household of the model.

In the Brazilian economy, the labor income has a large weight in the generation of the household income. Nevertheless, income transfers have an important participation, mainly for the poor households through the social security benefits and the social programs of direct transfers, and, in the case of rich households, through interest rate transfers and retirement pensions received from the public sector.

Therefore, despite the fact that the results partially reflect these characteristics, they are limited by the identical indexation of these transfers, which smoothes possible larger adjustments in the household income.

6.2 An Alternative Simulation with Trade Shock Policy and Capital Flow

In this alternative simulation, we reproduce the former shock simulation adding a different value for external direct investment through the net flow of capital account. In this way, we implemented with the 1996 base year model both values verified in 1990: the tariffs on imports and the level of external direct investment, which was 34% lower than in the base year. The simulation results can be interpreted as being the families' welfare changes in the absence of the *external* liberalization process.

As an answer for this combined movement, the trade deficit would have a forced reduction of 56 % due to the fall of imports (around 10 %) and the increase of exports (around 3,5 %).²⁰ Despite the exogenous implementation of the new capital flow, we believe that this hypothesis is very consistent with a closed economy movement that reduces the level of capital inflows, as verified at Brazilian economy before the recent process of external liberalization.

Table 5: Import Tariffs and capital inflow reduction					
Percentage Change in Employment					
	Total	Formal	informal	Skilled	Unskilled
Total	-0,982	-0,857	-1,185	-0,671	-1,092
Traditional Tradable	0,767	0,913	0,628	1,887	0,657
Modern Tradable	1,267	1,298	1,065	1,233	1,284
Non-Tradable	-1,776	-1,604	-2,077	-1,115	-2,075

Table 5, above, shows the employment variations. There is a total fall of $-0,982\%$, which is larger than in the former simulation. However, the type of adjustment is totally different. Now, the losers are the non-tradable sectors due to a fall of investment and of household consumption of service goods. Construction and Family Services are the activities with main decreases at employment.

On the other hand, the results for the traditional tradable sectors are no longer negative. The main reason is that exports will increase to compensate the decrease of capital inflows. Anyway, the most benefited sectors still would be the modern tradable protected by higher tariffs such as chemical and automobile industry.

Independently of the economic sectors, the employment reduction is more concentrated on informal and unskilled workers confirming the unequal tendency of jobs reduction.

Table 6: Import Tariffs and capital inflow reduction							
Percentage Change in the Average Wage							
	Worker 1	Worker 2	Worker 3	Worker 4	Worker 5	Worker 6	Worker 7
Total	-1,229	-1,587	-0,972	-1,639	-0,681	-1,696	-1,684

Note: **I1**-unskilled informal; **I2**-skilled informal; **I3**-formal with low skill; **I4**-formal with average skill; **I5**- formal with highly skilled; **I6**- low skilled public servant; **I7**- highly skilled public servant.

Analyzing table 6, we realize that there are a generalized loss of real wages. As in the previous simulation, the higher reduction of public servants' remuneration occurs because their employment is fixed in the model and so, the total effect goes to salaries. The differentiated impact among labor groups seems to compensate the loss of quantities (jobs). Anyway, it is evident that a policy to reduce the trade deficit, through import tariffs, causes a reduction at total labor expenditure.

Looking to labor groups in the private sector, we see that the major decreases are for formal with average skills (type 4) and skilled informal (type 2). The reason for this differentiation can be the effect of the wage curve that arbitrates between "loss of jobs" or "loss of real wages".

Table 7: Import Tariffs and capital inflow reduction							
Percentage Change in Household Income							
Family 1	Family 2	Family 3	Family 4	Family 5	Family 6	Family 7	Family 8
-1,791	-0,553	-1,866	-1,522	-1,268	-1,413	-1,176	-1,176

Note: **f1** – poor urban families headed by active individuals, **f2** – poor urban families headed by non-active individuals, **f3** – poor rural families, **f4** – urban families with low average income, **f5** – urban families with average income, **f6** – rural families with average income, **f7** – families with high average income, **f8** – families with high income.

The analysis of household income allows a better identification of which group is more affected by including all the effects in quantities and prices together. The main losers are rural poor (type 3) and urban poor families (type 1). On the other hand, the families with smaller losses are non-active urban poor families (type 2) and high-income families (type 8). These two groups share an important characteristic: their incomes have a significant participation of

²⁰ Comparing with the former simulation, we have export increases instead of reduction.

non labor income such as social security benefits for the first and civil servants social security benefits and capital interest for the second.²¹

7. Conclusion

In this paper, we have investigated the effect of a change in the external policy on some indicators related to social welfare. More precisely, we have estimated how the structures of wages and employment, as well as the distribution of household income would react to an import tariff rise back to the levels observed in the Brazilian economy in 1990. Also, these reactions were investigated in an environment of the tariff rise together with a decline in capital inflows.

Despite the modest aggregate effects for employment and wages, the reactions have been different for each type of worker. The effects on the employment structure have been slightly more pronounced. The tradable sectors that employ unskilled workers more intensively presented falls in employment in our import tariff rise simulation.

When we implemented the second type simulation, with reduction of capital inflow, the significance of results were increased, reinforcing the reduction of total income amount that was appropriated for all different group of workers.

From a distributive point of view, two hypotheses deserve attention. Concerning the wage structure, we have imposed rigidity in the wage differentials by sector of activity. Therefore, one would expect greater reactions in the employment levels rather than in the wages.

In relation to the formation of the household income, recall that we have fully indexed all types of transfers in a single way (with the price index constructed in the model), which implies in the impossibility of capturing all the effects arising from distributive conflicts. This fact poses an important question for CGE models aimed at measuring the effects on poverty and inequality: how to reconcile the general equilibrium theoretical structure and its respective properties with model specifications concerned with the distributive conflicts that exist in the flow of income transfers in situations where changes in relative prices take place.

An alternative to this “full indexation” would be to attribute different corrections to the various transfers existing in the model. In principle, the different family groups have

²¹ Again we emphasize that the same indexed factor is used to correct all types of income flows.

bargaining power on the price index level to be applied on the transfers from Government and on the distribution of these transfers among the family groups. For example, a specific family group can be able of having its transfers being multiplied by a price index higher than the general price index of the economy and/or increasing its share in the distribution of these resources over the family groups.

In our model, we assume that the family groups can not affect neither the magnitude of the price index applied to their transfers, nor their shares in the distribution of Government transfers. Actually, this would require the full modeling of the distributive conflicts, which is beyond the objectives of this paper. Even though, our guess is that this is not an easy task to be implemented without taking arbitrary assumptions and/or violating one of the principles of applied general equilibrium modeling.

This aspect is very important when we analyze the simulation effect for all household types. Despite the welfare losses for all families, it is evident that the major effect are for rural and urban poor families. The only poor family that avoids this process would be a family headed by non-active person. At this point, we are back to the former question: would the inactive dependent of public social security system have the same income correction of the financial assets held by income families? The most probable answer is no, which will reinforce the process of income concentration induced by the simulations.

Finally, we have emphasized that our results are based on CGE model that is not dynamic and, thus, it does not allow the incorporation of the future trajectory of investments and of the pattern of capital accumulation. Furthermore, the empirical literature have shown that tariff policies affect total factor productivity. Nevertheless, our position is that these effects would sustain the direction of the results that we have obtained, probably, with larger magnitudes.

Bibliographical References:

ARMINGTON, Paul. (1969). "A Theory of Demand for Products Distinguished by Place of Production", *IMF Staff Papers*, vol. 16, pp. 157-178.

World Bank (1999). *World Development Report*, Washington: The World Bank.

BARROS, Ricardo P. de; MENDONÇA, Rosane S. P. (1997). "Flexibilidade do mercado de trabalho brasileiro: uma avaliação empírica", Rio de Janeiro : IPEA, Texto para discussão 452.

BARROS, Ricardo P. de; CORSEUIL, Carlos H.; CURY, Samir. (2000) "Abertura comercial e liberalização do fluxo de capitais no Brasil: impactos sobre a pobreza e a desigualdade", in HENRIQUES, Ricardo (org.) Desigualdade e Pobreza no Brasil. Rio de Janeiro : IPEA, p. 271-298.

BARROS, Ricardo P. de; CORSEUIL, Carlos H.; CURY, Samir. (2000a) "Salário mínimo e pobreza: uma abordagem de equilíbrio geral", Pesquisa e Planejamento Econômico, vol. 30(2), p. 157-182.

BLANCHFLOWER, David G. and OSWALD, Andrew J. (1990). 'The Wage Curve', *Scandinavian Journal of Economics*, 92, 215-235.

BLANCHFLOWER, David G.; OSWALD, Andrew J. (1994). The wage curve. Cambridge : MIT Press.

BOURGUIGNON, François; MORRISSON, Christian (1989). External Trade and Income Distribution. Paris: OECD.

BOURGUIGNON, François; SILVA, Luiz P. da; STERN, Nicholas. (2002). Evaluating the Poverty Impact of Economic Policies. World Bank, draft, March 2002.

BOVENBERG, Ary L.; GRAAFLAND, Johan J.; de Mooij, RUUD A. (2000). "Tax reform and the Dutch labor market: an applied general equilibrium approach," Journal of Public Economics, Elsevier, vol. 78(1), p. 193-214, 10.

CURY, Samir (1998). Modelo de equilíbrio geral para simulação de políticas de distribuição de renda e crescimento no Brasil. São Paulo: FGV, Doctoral Thesis.

DEVARAJAN, Shantayanan; LEWIS, Jeffrey; ROBINSON, Sherman (1991). "From stylized to applied models: building multisector CGE models for policy analysis. USA", University of California at Berkeley, Department of Agriculture and Resources Economics, Working Paper 616.

DEVARAJAN, Shantayanan, HOSSAIN, Shaikh I. (1998). "The combined incidence of Taxes and Public Expenditure in the Philippines", *World Development*, vol.26(6).

FERGUSON, Linda; LEARMONTH, David; MCGREGOR, Peter G.; SWALES, J. Kim and TURNER, Karen (2003). "The Impact of the Barnett Formula on the Scottish Economy: A General Equilibrium Analysis", Department of Economics, University of Strathclyde, Glasgow, Scotland, Discussion paper 03-04.

GINSBURGH, Victor, KEYZER, Michiel (1997). The Structure of Applied General Equilibrium Models. MIT PRESS. Cambridge, Massachussets.

MELO, Jaime de; ROBINSON, Sherman (1989). “Productivity and externalities: models of export led growth”, California: University of California, Working Paper 520.

PINHEIRO, Armando C.; RAMOS, Lauro A. (1995). “Inter-industry wage differentials and earnings inequality in Brazil”, Estudios de Economía, vol. 21, p. 79-111.

KRUGMAN, Paul (1995). “Technology, Trade, and Factor Prices”, NBER Working Paper 5355.

KUME, Honório; PIANI, Guida; SOUZA, Carlos F.(2000). “A política brasileira de importação no período 1987-98: descrição e avaliação”, mimeo, Rio de Janeiro : IPEA.

REIS, Maurício (2002). “Mudanças na estrutura da demanda por trabalho qualificado e na composição da oferta e seus impactos sobre desemprego”, mimeo, Pontifícia Universidade Católica, Rio de Janeiro (PUC-Rio)

TOURINHO, Octávio; KUME, Honório; PEDROSO, Ana C. (2002). Elasticidades de Armington para o Brasil: 1986-2001. Rio de Janeiro: IPEA, Texto para discussão 901.

Appendix 1 – Results associated with a change of 100% in the exchange rate.

Table A1			
Earnings Response to an Exchange Rate Appreciation			
of 100%: percentage change in absolute values			
	Employment	Nominal Wages	Real Wages
Worker 1	-1,11E-11	100,00	8,26E-12
Worker 2	7,33E-13	100,00	2,22E-14
Worker 3	9,99E-13	100,00	-8,55E-13
Worker 4	-9,99E-14	100,00	5,77E-13
Worker 5	-1,11E-14	100,00	2,44E-13
Worker 6	2,22E-14	100,00	8,88E-14
Worker 7	-1,11E-14	100,00	1,55E-13

Table A2			
Earnings Response to an Exchange Rate Appreciation			
of 100%: percentage change in absolute values			
	Gross	Available	
Gov	100,00		
Large Firm	100,00	100,00	
Small Firm	100,00	100,00	
Household 1	100,00	100,00	
Household 2	100,00	100,00	
Household 3	100,00	100,00	
Household 4	100,00	100,00	
Household 5	100,00	100,00	
Household 6	100,00	100,00	
Household 7	100,00	100,00	
Household 8	100,00	100,00	