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# WOULD AGRICULTURAL TRADE LIBERALIZATION HELP THE POOR OF BRAZIL?

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## Introduction

Brazil exhibits a high degree of income concentration – that has persisted through the dramatic economic and political changes of the last 20 years. The resilience of this income distribution problem has attracted the attention of researchers both inside and outside Brazil. Although increased world trade offers many opportunities for the Brazilian economy to grow, the question of how much will such growth benefit the poor remains.

This paper is an effort to provide a quantitative “ex ante” assessment of such questions, using an applied general equilibrium (AGE) model of Brazil tailored for income distribution and poverty analysis. The model also has a regional dimension, allowing the comparison of effects between Brazil’s 27 states.

The plan of the paper is as follows: the background to this paper is described and compared to previous similar work. The next section shows some figures about the problem of poverty and income distribution in Brazil, with a brief review of the recent literature on the topic. The methodological approach to be pursued here is presented, with a discussion of the relevant literature on the many different approaches. Then the model itself is presented, with a discussion of its main aspects and of the database. Finally, results and conclusions are presented.

## 1.1 Background to the paper

This paper is part of a World Bank research project on “Poverty Alleviation Through Reducing Distortions to Agricultural Incentives”. The complete project has produced a time-series databank, showing how agricultural protection has evolved in different countries. While the wider project seeks to explain the political economy behind these changes, this

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paper is focused on a narrower question: how would reduction of agricultural protection affect the poor of Brazil?

## **1.2 Comparison of this paper with previous work**

This paper is one of several by the same authors which link CGE and micro-simulation models to analyze the income distribution effects of world trade policy changes (Ferreira Filho. and Horridge, 2006). Distinctive features of this most recent analysis are:

- The external terms of trade shocks, which (as explained above) derive from a World Bank Linkage model simulation of the world price effects of the removal of all agriculture-related distortions outside Brazil.
- The use of a more modern (2001) input-output database for the Brazil CGE model (previous studies used 1996).
- The use of a full inter-regional (bottom-up) CGE model of Brazil's 27 states, while previous studies used a simpler top-down or inter-regional model with regional differentiation of quantity (but not price) changes.

## **2. Poverty and income distribution evolution in Brazil: An overview**

Although Brazil has many poor people, it is not (on average) a very poor country. 77% of the world's people (and 64% of nations) have average income less than Brazil's<sup>3</sup>. But, due to particularly uneven income distribution, about 30% of Brazilians are poor, a figure which would be just 8 percent if Brazil's income were distributed as in other countries with similar per capita income (Barros et al, 2001).

The same authors show that in 1999 about 14 percent of the Brazilian population lived in households with income below the line of extreme poverty (indigence line, about 22 million people), and 34 percent of the population lived in households with income below the poverty line (about 53 million people). Even though the percentage of poor in the population has declined from 40 percent in 1977 to 34 percent in 1999, this level is still very high. The size of poverty in Brazil, measured either as a percentage of the population or in terms of a poverty gap, stabilizes in the second half of the 1980s until approximately 2001, although at a

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<sup>3</sup> . The numbers are from Barros et al (2001), who draw on the 1999 Report on Human Development.

lower level than was observed in the previous period. From 2001 the situation started to change, as will be seen below.

Barros and Mendonça (1997) have analyzed the relations between economic growth and reductions in the level of inequality upon poverty in Brazil. Among their main conclusions, these authors point out that an improvement in the distribution of income would be more effective for poverty reduction than economic growth alone, if growth maintained the current pattern of inequality. According to these authors, due to the very high level of income inequality in Brazil it is possible to dramatically reduce poverty in the country even without economic growth, just by turning the level of inequality in Brazil close to what can be observed in a typical Latin American country.

Brazilian poverty also has an important regional dimension. According to calculations by Rocha (1998) in a study for the 1981/95 period the richer South-East region of the country, while counting for 44 percent of total population in 1995 had only 33 percent of the poor. These figures were 15.4 percent for the South region (8.2 percent of poor), and 6.8 percent for the Center-West region (5.2 percent of poor). For the poorer regions, on the contrary, the share of population in each region is lower than the share of poor: 4.6 percent (9.3 percent of poor) for the North region, and 29.4 percent (44.3 percent of poor) for the North-East region, the poorest region in the country.

The behavior of wages and the allocation of labor throughout the 1980-99 trade liberalization period in Brazil was analyzed by Green *et al* (2001). Among the main findings the authors point out that wage inequality remained fairly constant for the 1980s and 1990s, with a small peak in the mid 80s. The main conclusion of the study is that the egalitarian consequences of trade liberalization were not important in Brazil for the period under analysis. As caveats, the authors note the low trade exposure of the Brazilian economy (around 13 percent in 1997), as well as the low share of workers that have completed college studies in total (1 in 12 workers at that time).

As stated previously, the pattern of poverty evolution in Brazil started to change from the year 2001. Several studies show different aspects of this evolution in the period. Barros *et al* (2007a), for example, show that there was a 0.9% annual increase in the national income in the 2001-2005 period, but the income of the richest decreased. The annual rate of increase of the 10% and 20% richest households' income was respectively -0.3% and -0.1%, which means that the increase in the national income implies a positive increase in the poorest households' income. Indeed, the rate of growth of the poorest households' income reached 8% a year in the same period. This income increase was also accompanied by a significant

fall in inequality: the Gini index fell by about 4.6% in the same period. The same authors showed that the correspond observed fall in poverty (a 4.5% reduction both in poverty and extreme poverty) was due mainly to the fall in inequality, and not in the income increase, on the contrary to what has been historically observed in Brazil.

This unusual pattern of poverty reduction has attracted the attention of many experts in the field, and uncovered an important aspect of the problem. In dealing with this issue Hoffmann (2006) found that the transfers from the federal government were one of the main determinants of the observed fall in poverty. According to that author 31.4% of the fall in the GINI index<sup>4</sup> and about 86% of the observed fall in poverty in 2002-2004 in Brazil were associated with the share of household income which includes the transfers of the Bolsa Familia, the main Brazilian federal government income transfer program. That effect is even greater if only particular regions inside the country are considered, as is the case of the Northeast region, where the transfers were responsible for 86.9% of the observed fall in the GINI index in the period considered.

The recent improvement in poverty in Brazil, then, is related to transfer programs, and so can be regarded as a short run initiative, not necessarily permanent. This highlights the importance of the assessment of the role played by market effects, such as those arising from trade, as a source of permanent gain in poverty alleviation, as is the objective of this paper.

### 3. Methodology

Although computable general equilibrium (CGE) models have long been used for poverty analysis, many have used a single representative household to represent consumer behavior. This limits the scope for income distribution and poverty analysis, since there are no intra-group income distribution changes.

Some CGE models recognize several household types, often distinguished by income level. For example, the Gurgel *et al.* (2003) study distinguished 20 household types, in a GTAP-derived multi-country model with additional Brazilian detail, where 10 urban and 10 rural household income types are recognized. Since they have varying expenditure and income source shares, the households are affected differently by economic changes. However, income or other differences *within* a particular household group are ignored. That

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<sup>4</sup> Barros et al (2007b) found an even larger effect. According to these authors the federal government transfers were responsible for about 50% of the observed fall in inequality in Brazil in the 2001-2005 period.

problem could be reduced by specifying more household types; although model size could become a constraint.

Other approaches draw on micro-simulation (MS) techniques. Here, a CGE model generates aggregate changes that are used to update a large unit record database, such as a household survey. This approach allows the model to take into account the full detail in household data, and avoids pre-judgment about aggregating households into categories. Changes in distribution of real income are computed by comparing the unit record data, pre- and post- updating.

Savard (2003) points out that the drawbacks to the approach are coherence between models, since the causality usually runs from the CGE model to the micro-simulation model, with no feedback between them. The methodology used in this paper addresses this difficulty by constraining certain aggregate results (eg, aggregate household use of each good) from the micro-simulation model to equal corresponding variables in the CGE model<sup>5</sup>.

The main advantages of the two-model (CGE, MS) approach are that the scaling of the microeconomic data to match the aggregated macro data can be avoided; more households can be accommodated in the MS model, and the MS model may incorporate discrete-choice or integer behavior that might be difficult to incorporate in the CGE model.

The CGE model used here, TERM-BR, is a static inter-regional model of Brazil based on the TERM<sup>6</sup> model of Australia (Horridge, Madden and Wittwer, 2005). It consists, in essence, of 27 separate CGE models (one for each Brazilian state), linked by the markets for goods and factors. For each region, the CGE model's structure is fairly standard. Each industry and final demander combines Brazilian and imported versions of each commodity to produce a user-specific CES composite good. Household consumption of these domestic/imported composites is modeled through the Linear Expenditure System, while intermediate demand is Leontief. Industry demands for primary factors follow a CES pattern, while labor is itself a CES function of 10 different labor types. The model distinguishes 41 single-product industries; while the agricultural ("Agriculture") industry distributes its output

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<sup>5</sup> Another approach would be, following Savard (2003), to use an iterative approach where the CGE simulation is rerun with adjustments to make it consistent with the (previous results from) the micro-simulation model. The process can be repeated until results converge.

<sup>6</sup> Versions of TERM have been prepared for Australia, Brazil, Finland, China, Indonesia and Japan. Related material can be found at [www.monash.edu.au/policy/term.htm](http://www.monash.edu.au/policy/term.htm).

(according to a CET constraint) between 11 agricultural commodities. Export volumes are determined by constant-elasticity<sup>7</sup> foreign demand schedules.

These regional CGE models are linked by trade in goods underpinned by large arrays of inter-regional trade that record, for each commodity, source region and destination region, the values of Brazilian and foreign goods transported, as well as the associated transport or trade margins<sup>8</sup>. Users of, say, vegetables in São Paulo substitute between vegetables produced in the 27 states according to their relative prices, under a CES demand system<sup>9</sup>.

A variety of labor market closures are possible. For the simulations reported here, employment of each of the 10 occupational groups was assumed to be fixed nationally, but labor would migrate to regions where real wages grew more (based on a CET formulation).

With 27 regions, 42 industries, 52 commodities, and 10 labor types, the model contains around 1.5 million non-linear equations. It is solved with the GEMPACK software. The CGE model is calibrated with data from two main sources: the 2001 Brazilian Input-Output Matrix (IBGE. <http://ibge.gov.br>)<sup>10</sup>, and some shares derived from the Brazilian Agricultural Census (IBGE, 1996) and the Pesquisa Agrícola Municipal (IBGE, 2001, also available at <http://ibge.gov.br> ).

On the income generation side of the model, workers are divided into 10 different categories (occupations), according to their wages. These wage classes are then assigned to each regional industry in the model. Together with the revenues from other endowments (capital and land rents) these wages will be used to generate household incomes. Each activity uses a particular mix of the 10 different labor occupations (skills). Changes in activity level change employment by sector and region. This drives changes in poverty and income distribution. Using the expenditure survey (POF, mentioned below) data we extend the CGE model to cover 270 different expenditure patterns, composed of 10 different income classes in 27 regions. In this way, all the expenditure-side detail of the micro-simulation dataset is incorporated within the main CGE model.

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<sup>7</sup> For the simulations reported here, we set the export demand elasticities to values derived from the GTAP model, so as to increase consistency between results for the world and Brazil models.

<sup>8</sup> The dimensions of this margins matrix are:  $52 \times 2 \times 27 \times 27$  [COM\*SRC\*MAR\*REG\*REG].

<sup>9</sup> For most goods, the inter-regional elasticity of substitution is fairly high. To ease the computational burden, we assume that all users of good G in region R draw the same share of their demands from region Z.

<sup>10</sup> Actually, the 2001 Brazilian Input-Output database used in this study was generated by the author and colleagues in a previous study (Ferreira Fo, Santos and Lima, 2007) based on the Brazilian National Accounting System tables, since the last official Input-Output table published by the Brazilian statistical agency is from 1996.



There are two main sources of information for the household micro-simulation model: the Pesquisa Nacional por Amostragem de Domicílios –PNAD (National Household Survey – IBGE, 2001), and the Pesquisa de Orçamentos Familiares- POF (Household Expenditure Survey, IBGE, 1996). The PNAD contains information about households and persons, and shows a total of 331,263 records. The main information extracted from PNAD were wage by industry and region, as well as other personal characteristics such as years of schooling, sex, age, position in the family, and other socio-economic details.

The POF, on the other hand, is an expenditure survey that covers 11 metropolitan regions in Brazil. It was undertaken during 1996, and covered 16,014 households, with the purpose of updating the consumption bundle structure. The main information drawn from this survey was the expenditure patterns of 10 different income classes, for the 11 regions. One such pattern was assigned to each individual PNAD household, according to each income class. As for the regional dimension, the 11 POF regions were mapped to the larger set of 27 CGE regions. Here it must be stressed that the POF survey just brings information about urban areas (the metropolitan areas of the main state capitals).

### **3.1 Model running procedures**

As mentioned before, the model consists of two main parts: a Computable General Equilibrium model (CGE) and a Household Model (MS). The models are run sequentially, with consistency between the two models assured by constraining the micro simulation model to agree with the CGE model. The CGE model is sufficiently detailed, and its categories and data are close enough to those of the MS model that the CGE model predicts MS aggregate behavior (that is also included in the CGE model, such as household demands or labor supplies) very closely. The role of the MS model is to provide extra information, for example about the variance of income within income groups, or about the incidence of price and wage changes upon groups not identified by the CGE model, such as groups identified by ethnic type, educational level, or family status. Note that to conform with the Linkage model structure labor supplies were fixed. Furthermore, each household in the micro data set had one of the 270 expenditure patterns identified in the main CGE model. There is very little scope for the MS to disagree with the CGE model.

The simulation starts with a set of trade shocks generated by a World Bank's Linkage model simulation of the abolition of agricultural distortions outside Brazil. These shocks consist of changes in import prices and in export demands. The export demand changes are implemented via vertical shifts in the export demand curves facing Brazil.

The trade shocks are applied, and the results calculated for 52 commodities, 42 industries, 10 households and 10 labor occupations, all of which vary by 27 regions. Next, the results from the CGE model are used to update the MS model. At first, this update consists basically in updating wages and hours worked for the 263,938 workers in the sample. These changes have a regional (27 regions) as well as sectoral (42 industries) dimension.

The model then relocates jobs according to changes in labor demand<sup>11</sup>. This is done by changing the PNAD weight of each worker (see Ferreira Filho. and Horridge, 2006, for details) in order to mimic the change in employment (this procedure is called the “quantum weights method”). In this approach, then, there is a true job relocation process going on. Although the job relocation has very little effect on the distribution of wages between the 270 household groups identified by the CGE model, it may have considerable impact on the variance of income within a group.

One final point about the procedure used in this paper should be stressed. Although the changes in the labor market are simulated for each adult in the labor force, the changes in expenditures and in poverty are tracked back to the household dimension. A PNAD key links persons to households, which contain one or more adults, either working in a particular sector and occupation, or unemployed, as well as dependents. In the model then it is possible to recompose changes in the household income from the changes in individual wages. This is a very important aspect of the model, since it is likely that family income variations are cushioned, in general, by this procedure. If, for example, one person in some household loses his job but another in the same household gets a new job, household income may change little (or even increase). Since households are the expenditure units in the model, we would expect household spending variations to be smoothed by this income pooling effect. On the other hand, the loss of a job will increase poverty more if the displaced worker is the sole earner in a household.

## 4. The base year picture

In this section the above description of poverty and income inequality in Brazil is extended. The reference year for the analysis is 2001. Some general aggregated information about poverty and income inequality in Brazil can be seen in Table 1.

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<sup>11</sup> The methodology is described in more detail elsewhere (see Ferreira Filho. and Horridge, 2005). Here we present only the main ideas.

The rows of Table 1 correspond to household income classes, grouped according to POF definitions<sup>12</sup>, such that POF[1] is the lowest income class, and POF[10] the highest. A fair picture of income inequality in Brazil in 2001 emerges from the table. It can be seen that the first 5 income classes, while accounting for 52.6 percent of total population in Brazil, get only 17 percent of total income. The highest income class, on the other hand, accounts for 11 percent of population, and about 45 percent of total income. The Gini index associated with the income distribution in Brazil in 2001, calculated using an equivalent household<sup>13</sup> basis, is 0.58, placing Brazil's income distribution among the world's worst.

The unemployment rate is also relatively higher among the poorer classes. This is an important point, due to its relevance for modeling. The opportunity to get a new job is probably the main element lifting people out of poverty: hence the importance for poverty modeling of allowing the model to capture the existence of a switching regime (from unemployment to employment), and not just changes in wages. As can be seen in Table 1, the unemployment rate reaches 36.5 percent among the lowest income group (persons above 15 years), and just 7.7 percent among the richest. The percentage of white people also increases considerably with household income, while the percentage of children decreases markedly. Although this analysis does not specifically focus on these aspects, the microsimulation approach allows us to measure the effects of a policy change on groups not distinguished in the main CGE model.

The poverty line for this study was defined to be one-third of the average household income<sup>14</sup>. According to that criterion 30.8 percent of the Brazilian households in 2001 would be poor<sup>15</sup>. This would comprise 96.2 percent, 76.6 percent and 53.5 percent, respectively, of households in the first three income groups<sup>16</sup>, or 34.5 million out of 112 million households in 2001.

Table 2 shows how each POF group contributes to the three Foster-Greer-Thorbecke

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<sup>12</sup> POF[1] ranges from 0 to 2 minimum wages, POF[2] from 2+ to 3, POF[3] from 3+ to 5, POF[4] from 5+ to 6, POF[5] from 6-8, POF[6] from 8-10, POF[7] from 10-15, POF[8] from 15-20, POF[9] from 20-30, and POF[10] above 30 minimum wages. The minimum wage in Brazil in 2001 was around US\$76 per month.

<sup>13</sup> The equivalent household concept measures the subsistence needs of a household by attributing weights to its members: 1 to the head, 0.75 to the other adults, and 0.5 to the children (eg, to feed 2 persons does not cost double). Because poverty is defined here on an equivalent basis, a few (very large) families in middle incomes groups fall below the poverty line.

<sup>14</sup> This poverty line is equivalent to US\$ 48.00 in 2001.

<sup>15</sup> Barros et al (2001), working with a poverty line that takes into account nutritional needs, find that 34 percent of the Brazilian households were poor in 1999.

(1984) (FGT, for short) overall measures of poverty: FGT0 – the proportion of poor households (i.e., below the poverty line), FGT1 – the average poverty gap ratio (proportion by which household income falls below the poverty line), and FGT2 – a measure of inequality *among* the poor.

Table 2 shows a large average poverty gap for the two lowest income classes. Together these two income classes contribute to about half of the general average poverty gap index of the economy. The first income class, for example, falls below the poverty line by about 70%. Thus, large income increases for the poor are needed to significantly change the number in poverty.

As stated before, this general poverty and inequality picture also has an important regional dimension in Brazil, given that economic activity is located mainly in the South-East region. This is particularly true of manufacturing; agriculture is more dispersed among regions. Table 3 shows more information about the regional variation of poverty and income inequality. The map in Figure 1 shows where regions are located, and shades them according to proportions of households in poverty.

As it can be seen in Table 3, the states in the North (N) region account for 8 percent of total population, compared to 23.5 percent for the North-East (NE), 45 percent in the South-East (SE), 16 percent for South (S), and 7.2 percent for the Center-West (CW). In the SE region the state of São Paulo alone accounts for 22.9 percent of total Brazilian population.

The fourth column in Table 3 shows the share of households below the poverty line in each region, as a proportion of total regional households. The states in the NE region (states numbered from 8 to 16 in the table) plus the states of Tocantins and Para in the N region present the highest figures for this indicator, showing that these states are relatively poorer. If, however, regional population is taken into account, the fifth column show that the populous regions of Ceará, Pernambuco, Bahia, Minas Gerais and São Paulo give higher contributions to the Foster-Greer-Thorbecke poverty gap index<sup>17</sup>. These figures are the contribution of each state to the total poverty gap index in Brazil expressed as a proportion of the poverty line (see column total). We can see that the average poverty gap in Brazil in 2001 is a 14.5 percent insufficiency of income to reach the poverty line.

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<sup>16</sup> The proportion of households below the poverty line in the other income groups are 0.284 percent for the 4<sup>th</sup>, 0.14 percent for the 5<sup>th</sup>, 0.04 percent for the 6<sup>th</sup>, 0.008 percent for the 7<sup>th</sup>, and 0.001 percent for the 8<sup>th</sup>. There are no households below the poverty line for the two highest income classes.

<sup>17</sup> The poverty gap and poverty line values are constructed with “adult equivalent” per capita household income.

The last column in Table 3 shows the regional insufficiency gap. The picture is similar to what was seen for the number of households below the poverty line, with the states in the NE regions plus the states of Tocantins and Para showing the highest poverty gaps. Two states in the South region (Santa Catarina and Rio Grande do Sul) show the lowest poverty gaps in Brazil, followed closely by São Paulo. Interesting enough, Amapa state (in the North region) shows a poverty gap in line with the richer states of the S-SE. This result, however, should be viewed with caution, since that state has a very small share of total population and the result could be due to sampling bias. The PNAD survey does not cover the rural areas of the Northern states, where poverty is usually concentrated.

More information about the labor structure of the economy can be seen in Table 4 and Table 5. In these tables sectoral wage bills are split into the model's 10 occupational groups. The occupational groups are defined in terms of a unit wage ranking. More skilled workers, then, would be those in the highest income classes, and vice-versa. As can be seen in Table 4, Agriculture is the activity most dependent on unskilled labor (40.5 percent of that sector's labor bill), while Petroleum and Gas Extraction and Petroleum Refinery are the most intensive users of skilled labor (10<sup>th</sup> labor class) using activities, with Financial Institutions coming next. If labor inputs were measured in hours (rather than in values) the concentration of low-skill labor in Agriculture would be even more pronounced.

Agriculture is also the sector that hires most unskilled labor in Brazil, around 41 percent of total workers in income class 1 (Table 5). The Trade sector is the second largest employer of this type of labor. As for the higher income classes, we see that the Financial Institutions and Public Administration sectors hire the largest numbers of well-paid workers.

Table 6 shows the distribution of occupation wages (OCC) classes among the household income classes (POF classes). In this table, the rows show household income classes, while the columns show the wage earnings by occupation. It is evident from this table that the wage earnings of the higher wage occupations (OCC10, for example) are concentrated in the higher income households, and *vice-versa*. Most of the wages earned by workers in the first wage class (OCC1) accrue to the three poorest households, POF[1]-[3]. All the workers in the highest wage class, on the other hand, are located in households from the 8<sup>th</sup> income class and above. It is possible to see, then, that the household income classes are highly positively correlated with the occupational wage earning classes.

## 5. The simulations

This paper presents results for the agricultural liberalization scenario, which comprises:

- For agricultural and lightly processed food<sup>18</sup>, removal of all trade (import and export) taxes and subsidies, removal of all output taxes and subsidies, and removal of farm input subsidies;
- For other non-agricultural sectors, removal of all import tariffs and removal of export taxes.

### 5.1 Model closure

The model closure aimed to mimic the World Bank Linkage model that generated the foreign price scenario. On the supply side, national employment by occupation<sup>19</sup> is fixed, with inter-regional real wage differentials driving labor migration between regions<sup>20</sup>. The model allows industries to substitute between occupations, driven by relative wages. Similarly capital is fixed nationally but is mobile between sectors and regions (all rates of return move as one). The land stock in each region (used just in the Agriculture and mining sectors activities) is fixed<sup>21</sup>. In the mining sectors (mineral extraction and petrol and gas extraction), however, this stock is treated as a “natural resources stock”, and so is not used to compute the price of agricultural land, which is restricted to agriculture. Since agriculture is an activity that produces 11 products, land is allocated to these competing products through relative prices, allowing the crop mix to change.

On the demand side, real government demands are fixed, while investment in each region and sector follows the growth of the corresponding capital stock<sup>22</sup>. A fixed [nominal trade balance/GDP] ratio enforces the national budget balance, which is accommodated by

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<sup>18</sup> Highly processed food, beverages and tobacco were excluded, which are GTAP sectors 25 and 26. In the Brazil’s model classification, these sectors correspond to CoffeeInd, VegetProcess and OthFood.

<sup>19</sup> There is a tension between this labor closure and Brazilian reality. The microdata show substantial unemployment of less-skilled groups in all regions. An alternate scenario, where fixed real wages replaced national labour constraints, yielded results similar to those reported here.

<sup>20</sup> For a particular occupation and region, the inter-sectoral wage variation was fixed. For the microsimulation it was assumed that jobs created (or lost) in a region were allotted to (or taken from) households in that region.

<sup>21</sup> The factor market closure causes the model to generate percent changes in prices for 10 labour types, capital and land; the price changes vary across regions. Percent changes in demand for each of the 12 factors vary in addition by sector and region. Each adult in the PNAD microdata is identified by region and labour type; those employed are also identified by sector. Changes in microdata poverty levels are driven by wage changes and by the redistribution of jobs between sectors and regions (and hence between households).

changes in real consumption. The trade balance, then, drives the level of absorption. The national consumer price index (CPI) is the model's numeraire. And, finally, a tax replacement mechanism is in force, allowing the direct tax rate to flow endogenously to keep the total (indirect plus direct) government tax collection unchanged after the elimination of trade taxes and subsidies. This mechanism is the same as used in the Linkage model.

## 6. Results

### 6.1 The CGE model results

The Brazilian economy has a limited exposure to external trade. The shares of exports and imports in total GDP were respectively 13.8 percent and 14.7 percent in the 2001 base year (those figures were respectively 7.0 and 8.9 percent in 1996). Table 7 shows more information about the structure of Brazilian external trade as well as of related parameters and production structure, while Table 8 shows the nature and size of the shocks applied to the model.

As stated before, the shocks applied to the model were generated by a previous run of the World Bank Linkage model, where agricultural liberalization scenarios were implemented. The world price effects on the Brazilian economy were then transmitted to the Brazil CGE model through import prices changes, and shifts in the demand schedules for the Brazilian exports<sup>23</sup>.

An inspection of Table 7 and Table 8 can give an idea of the importance of these shocks combined with the importance of each commodity in Brazilian external trade. As can be seen, Brazilian exports are spread among many different commodities, with no specialized trend. Raw agricultural products have very small share (mostly soybeans) in total exports. Processed food and agricultural-based exports (including wood and furniture, rubber, paper, textiles and apparel), however, account for a significant 30% share of total exports in the base year, highlighting the importance of Agriculture in the Brazilian economy.

Imports as a share of each domestic production are concentrated in wheat, oil, machinery, electric materials and electronic equipment, and chemical products. In terms of

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<sup>22</sup> That is, investment/capital ratios are fixed. With national capital stock, changes in aggregate investment are also limited, but do arise from inter-sectoral variations in initial investment/capital ratios.

<sup>23</sup> The shifts in the demand schedules for Brazilian exports were calculated using export price and quantity results (and export demand elasticities) from the World Bank Linkage model, using the method of Horridge and Zhai (2005).

total import shares, however, oil products (raw and refined), machinery, electric materials and electronic equipment, and chemical products are the most important products.

Table 7 also shows some relevant parameters and other production characteristics of the model. The Armington elasticities are borrowed from the LINKAGE model. The export demand elasticities (not shown in the table), are equal to the GTAP region-generic elasticity of substitution among imports in the Armington structure.

The Agriculture sector is modeled as a multi-production sector, producing 11 commodities. Thus the capital/labor ratio (ratio of values) in Table 7 is the same for every agricultural product. The value of land is not included in the value of capital here. If land was included, the value of the capital/labor ratio in agriculture would rise to 0.99.

The values of the production taxes shocks can be seen in Table 9. The figures in the table are the shock to the level or the production tax rate in each sector, for the selected sectors. Agriculture (primary agriculture and livestock production), for example, is the only one sector with a negative (-0.7% or -0.007 points in levels) production tax in the database. A shock to eliminate this tax then is a 0.007 points increase in that tax rate.

In what follows, we present some macro results in order to establish a benchmark for the regional and poverty analysis. National macro results can be seen in Table 10. Because the closure fixes total supply of all primary factors (land, the 10 categories of labor, and capital), GDP shows only a slight increase in the simulations. The real exchange rate rises (revaluation) as a result of the shocks, with corresponding gains in the external terms of trade.

For factor market results, recall that land is used only by Agriculture, while capital and the 10 types of labor are fixed nationally, but mobile between sectors. As a result of the simulation, the average (aggregated) capital rental increases. With capital stocks and labor fixed in total, the expanding industries would attract capital and labor from the contracting ones. In these industries those with falling capital/labor ratios increase the marginal productivity of capital, and hence capital returns, determining an increase in aggregated results. The price of agricultural land also shows a 28% increase in the national average, reflecting the increase in land demand in every state, as a consequence of the increase in production of activities using this factor (Agriculture). National changes in industry output are shown in Table 11.

As can be seen in Table 11, agriculture and agricultural related industries (the food industries) would expand. Model results show also a general fall in activity in the Brazilian manufacturing sectors following the trade liberalization. This suggests that regions specializing in manufacturing would fare worse. Indeed, this can be seen in Table 12, where



regional results are presented. In this table, states are grouped according to their macro-regions inside Brazil. For each of the 10 labor types, total employment is fixed, so labor demand will be redistributed among regions according to changes in regional industry output. As it can be seen, employment falls in São Paulo and Rio de Janeiro in the Southeast region (the most populous and industrialized states), and also in Amazonas and Rio Grande do Norte.

The states of São Paulo and Rio de Janeiro are industrial states, hosting the bulk of Brazil's manufacturing. As seen before, manufacturing is contracting in general. The same effect drives the result for the Amazonas state, where there is a free exporting zone. Interestingly, the trade liberalization scenario redistributes economic activity towards poorer regions. However, this occurs because higher value-added sectors (manufacturing) shrink, and relatively lower value-added sectors (agriculture) grow, which raises an important issue related to pattern of specialization in the Brazilian economy under this scenario.

## 6.2 Poverty and income distribution results

It was seen in the previous section that model results are differentiated among regions and industries. The outcome of these changes on income and income inequality measures as well as over income-group-specific consumer price indices are presented in Table 13 and discussed below. In this table, the POF groups are groups of household income, being POF[1] the lowest one and POF[10] the highest. As it can be seen in the table, the GINI (inequality) index fell by about 1.7% in the simulation. Even though not a remarkable fall, this figure is not negligible. The GINI index usually changes very little with policy measures in the short run, which accords with observed facts in Brazil in the nineties. Even though the country faced a strong trade liberalization process in the decade, it was observed that the GINI index changed very little in the period.

The closure fixes aggregate primary factor supplies, preventing much GDP increase, and highlighting the allocative effects inside the economy. The observed fall in the GINI index, then, is a result of these allocative effects, a combination of changes in wages and the labor demand structure in expanding and contracting sectors due to the shocks.

The literature on poverty, however, recognizes the importance of the fall in inequality for growth, and vice-versa. Barros et al (2007a) have estimated the “equivalent growth” for Brazil, defined as “the growth rate which would reproduce the same reduction in poverty caused by a certain fall in the inequality” (Barros et al, 2007a). According to those authors’ estimates, from a poverty point of view the recent 4.6% fall in inequality observed in Brazil

(2001-2005) is equivalent to a balanced growth rate of 11% (with no change in inequality), leading to the conclusion that a 1% fall in inequality is equivalent to a 2.4% growth rate. Said differently, if the poor had to choose, they would be indifferent to a 1% fall in the GINI index or a 2.4% balanced increase in “per capita” income in Brazil. The equivalent growth would be even higher if the poverty gap or the severity of poverty were considered, respectively of 16% and 21%<sup>24</sup>.

The simulation result of 1.7% fall in inequality, as measured by the GINI index, then, would be equivalent, in terms of poverty reduction, of a 4.1% growth rate above the trend between the old and the new static equilibrium, which stresses the significance of the simulated scenario.

The CPI column in each scenario is the particular CPI change for each household income class, since the consumption bundle of each class is different. Although the CPI results differ less (between households) than the income results, the trend is that living costs go up more for the poor, who consume more food. There is a strong increase in some food prices, like meats, driven mainly by the liberalization in the rest of the world. This is in contrast with the expectation of Rocha (1998) that opening the Brazilian economy to the external market would help reduce inequality in Brazil through reductions in prices in the poorest regions. Our results suggest that the CPI would actually go up more in the lowest income classes, but these are more than compensated by the income increase.

The highest positive changes in household income are concentrated on the lowest income households, decreasing monotonically as household income increases. Indeed, as can be seen in Table 14, the reduction in the number of poor households is concentrated in the poorest groups. High positive figures in POF groups 6, 7 and 8 are percentage changes over very low numbers, since there are very few poor households in these income classes<sup>25</sup>.

The headcount ratio index (FGT0 in Table 14) captures only the extension of poverty, not its intensity. The change in the intensity of poverty can be seen through the FGT1 index, the insufficiency of income ratio. A reduction in FTG1 means a reduction in the severity of poverty inside each household income class. As seen from Table 14, the FGT1 index decreases more than the headcount ratio in the poorest three household income groups. This means that there was actually an income distribution improvement, but not enough to drive a

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<sup>24</sup> Those values would be even higher if extreme poverty was considered, see Barros et al (2007b), p. 17-18.

<sup>25</sup> Some middle-income households have many family members. With low per-capita income, they fall below the poverty line.

large number of persons (or households) out of poverty. This is due to the high value of those indices in the base year, as noticed before.

Finally, Table 15 shows model results relating to the regional breakdown inside Brazil. These results summarize at regional level the outcome of the simulated scenario, as a net effect of the regional industries. They reflect, then, the pattern of regional specialization in production. Only in the large, industrialized states of São Paulo and Rio de Janeiro, and in Amazonas (where there exists a free processing zone specialized in electronic products) would the number of households (FGT0) below the poverty line increase. This result is related to the high concentration in São Paulo and Rio de Janeiro of contracting industries, mainly automobiles, machinery and tractors, electric materials, electronic equipment, other vehicles and spare parts, and chemicals.

The poverty gap, however, as measured by the FGT1 index, increases only in Rio de Janeiro, and not in São Paulo or Amazonas. This is because the share of Agriculture in GDP is larger in São Paulo (indeed it accounts around 20% of Brazil's agricultural production). Higher wages and employment in agriculture reduce the poverty gap in the state, even though the fall in the manufacturing activities causes the number of poor to increase. Rio de Janeiro, on the other hand, is less agricultural, so that rising agricultural wages and employment do not compensate for the fall in its manufacturing industries.

## **7. Concluding Remarks**

In conclusion, the simulated trade liberalization scenario has positive impacts on poverty in Brazil. Even though the country is not very oriented towards external trade, the strong price and external demand push generated by the trade liberalization scenario causes agriculture to expand considerably, with positive effects on poverty. This highlights the importance that agriculture still has for the poorest in Brazil. Despite the steady decline over time in agriculture's share of GDP, the sector still employs most of the nation's poorest. Actually, the agricultural sector has a disproportionate importance for the poorest workers, compared to its share in GDP.

For regions, this implies that in Brazil's manufacturing states, São Paulo and Rio de Janeiro (and Amazonas, but in much smaller scale), the number of poor households increases. This happens because the relative protection of manufacturing is reduced, and agriculture expands while manufacturing contracts. This is an important point to be stressed in this discussion. Brazil, like most of the other countries in Latin America, pursued in the past

import substitution policies which benefited the manufacturing sector, under the “infant industry” argument. The model results show that the trade liberalization scenario would act in the opposite direction, benefiting agricultural at the expense of industrial sectors, a significant political economy question.

Another important point arising from this analysis is the fall in inequality -- which is more dramatic than the fall in the number in poverty. As discussed before, this inequality improvement would be equivalent, in terms of poverty reduction, to a significant rate of economic growth. Furthermore, the higher fall in the poverty gap, mainly on the poorest household groups, suggest that the poorest among the poor tend to benefit most from the global trade liberalization scenario. In fact this result holds for every state in Brazil except Rio de Janeiro.

In this paper the “rural x urban” split was avoided, due to the difficulties of this classification. The household composition, however, takes into account the full occupational diversity in the economy, and captures the “multi-activity” phenomenon (many households include workers in both agriculture and manufacturing), which has been intensely researched in Brazil<sup>26</sup>. Approaching poverty by the household dimension, instead of by the personal dimension, and tracking the changes in the labor market from individual workers to households is an important modeling issue. In the PNAD 2001 data used here, the income of the family head accounts for only 65 percent of household income in Brazil. Using head-of-household income as a proxy for household income may poorly predict the effect of policy changes, as convincingly argued by Bourguignon et al (2003). If spending (and welfare) is in any sense a household phenomenon, ours is the appropriate method.

Finally, the positive impacts found here suggest a policy complementary to those used at present in Brazil to fight poverty. As pointed out by Giambiagi and Franco (2007), one of the strategies used by the federal government in Brazil for poverty alleviation, namely the increase in the minimum wage, seems to be close to its limit in terms of efficacy, especially in the poorest, Northeast, region. As shown here this region would be one of the most benefited by global trade liberalization. Thus, global freer trade is another way for Brazil to help its poor.

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<sup>26</sup> On the multi-activity in the Brazilian agriculture, see, for example, Del Grossi and Graziano da Silva (1998) ; Graziano da Silva and Del Grossi (2001); and Nascimento, (2004).

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**Figure 1: Brazil states shaded according to proportion in poverty. 2001.**



The states of São Paulo, Rio de Janeiro, Minas Gerais, Rio Grande de Sul, Parana and Santa Catarina account for 78% of GDP, 58% of population and 37% of poor people.

**Table 1. Poverty and income inequality in Brazil, 2001.**

Income group	PrPop	PrInc	AveHouInc	UnempRate	PrWhite	AveWage	PrChild
POF[1]	10.7	0.9	0.1	32.6	35.2	0.2	46.2
POF[2]	8.0	1.8	0.4	17.3	38.3	0.3	37.2
POF[3]	16.0	5.2	0.6	10.4	42.0	0.4	35.1
POF[4]	7.3	3.1	0.8	8.8	45.1	0.4	32.5
POF[5]	11.0	5.8	1.0	7.5	49.2	0.5	28.7
POF[6]	7.9	5.1	1.2	7.4	53.4	0.6	26.4
POF[7]	12.9	11.1	1.7	6.8	60.3	0.8	24.5
POF[8]	7.5	8.7	2.3	6.1	66.3	0.9	21.5
POF[9]	7.7	12.7	3.1	5.9	71.2	1.4	20.5
POF[10]	10.9	45.7	7.9	4.2	81.6	3.2	17.7
Total	100.0	100.0	---	---	---	---	---

PrPop = % in total population; PrInc = % in country total income; AveHouInc = average household income; UnempRate = unemployment rate; PrWhite = % of white population in total; AveWage = average normalized wage; PrChild = share of population under 15 by income class.  
Source: PNAD, 2001.



**Table 2. POF group contributions to FGT poverty indices**

POF group	% of all families	Share below poverty line	Average poverty gap	Contributions to FGT0	Contributions to FGT1	Contributions to FGT2
POF[1] poorest	10.7	0.9617	0.7334	0.1122	0.0856	0.0715
POF[2]	8.0	0.7657	0.3047	0.0716	0.0285	0.0135
POF[3]	16.0	0.5355	0.1496	0.0877	0.0245	0.0092
POF[4]	7.3	0.2837	0.0539	0.0202	0.0038	0.0011
POF[5]	11.0	0.1143	0.0189	0.0122	0.0020	0.0005
POF[6]	7.9	<b>0.0390</b>	0.0054	0.0029	0.0004	0.0001
POF[7]	12.9	0.0082	0.0009	0.0010	0.0001	0.0000
POF[8]	7.5	0.0008	0.0001	0.0001	0.0000	0.0000
POF[9]	7.7	0.0000	0.0000	0.0000	0.0000	0.0000
POF[10] richest	10.9	0.0000	0.0000	0.0000	0.0000	0.0000
sum=100		FGT0= ave=0.3079	FGT1= ave=0.1449	FGT0= sum=0.3079	FGT1= sum=0.1449	FGT2= sum=0.0960

FGT0: the proportion of poor households below the poverty line; FGT1: the average poverty gap; FGT2: extent of inequality among the poor.

**Table 3. Regional poverty and income inequality figures. Brazil, 2001.**

Regions	Macro-regions*	Population share of each region	Proportion of poor households in regional population	Regional Contribution to the Poverty Gap	Regional Average Poverty Gap
1 Rondonia	N	0.005	0.338	0.001	0.147
2 Acre	N	0.002	0.356	0.000	0.176
3 Amazonas	N	0.011	0.396	0.002	0.196
4 Roraima	N	0.001	0.347	0.000	0.152
5 Para	N	0.023	0.425	0.005	0.194
6 Amapa	N	0.003	0.151	0.000	0.069
7 Tocantins	N	0.006	0.429	0.001	0.180
8 Maranhao	NE	0.029	0.579	0.008	0.288
9 Piau	NE	0.015	0.564	0.005	0.304
10 Ceara	NE	0.042	0.540	0.011	0.267
11 RGNorte	NE	0.016	0.471	0.004	0.218
12 Paraiba	NE	0.019	0.550	0.005	0.257
13 Pernambuco	NE	0.045	0.512	0.011	0.248
14 Alagoas	NE	0.015	0.577	0.004	0.289
15 Sergipe	NE	0.010	0.503	0.002	0.239
16 Bahia	NE	0.073	0.520	0.019	0.256
17 MinasG	SE	0.108	0.301	0.014	0.133
18 EspSanto	SE	0.019	0.324	0.003	0.144
19 RioJaneiro	SE	0.095	0.202	0.009	0.095
20 SaoPaulo	SE	0.229	0.166	0.019	0.083
21 Parana	S	0.059	0.237	0.006	0.100
22 StaCatari	S	0.034	0.136	0.002	0.055
23 RGSul	S	0.067	0.179	0.005	0.073
24 MtGrSul	CW	0.013	0.289	0.002	0.120
25 MtGrosso	CW	0.015	0.251	0.002	0.106
26 Goias	CW	0.031	0.300	0.004	0.126
27 DF	CW	0.013	0.219	0.001	0.106
Total	Brazil	1.000	0.308	0.145	0.145

\*Macro-Regions: N = North; NE = North-East; SE = South-East; S = South; CW = Center-West

**Table 4. Share (%) of occupations in each activity's labor bill.**

Sectors	OCCUPATIONS (WAGE CLASS)										Total
	1	2	3	4	5	6	7	8	9	10	
Agriculture	40.5	30.2	5.8	6.0	5.2	3.3	3.7	1.8	1.9	1.6	100
MineralExtr	12.0	19.4	6.8	6.9	8.4	6.1	12.8	9.9	10.8	6.9	100
PetrGasExtr	0.0	0.0	0.0	0.9	0.9	6.1	16.1	12.1	22.8	41.1	100
MinNonMet	7.1	18.8	7.4	8.9	11.5	11.8	14.1	7.6	7.4	5.3	100
IronProduc	1.9	6.8	4.0	6.3	10.2	9.7	22.7	14.0	15.4	9.1	100
MetalNonFerr	1.9	6.8	4.0	6.3	10.2	9.7	22.7	14.0	15.4	9.1	100
OtherMetal	1.9	6.8	4.0	6.3	10.2	9.7	22.7	14.0	15.4	9.1	100
MachTractor	0.5	4.6	1.9	4.8	6.8	9.0	19.6	17.2	16.8	18.8	100
EletricMat	0.4	3.8	2.6	3.3	10.3	11.6	20.4	15.5	17.0	15.1	100
EletronEquip	0.4	3.8	2.6	3.3	10.3	11.6	20.4	15.5	17.0	15.1	100
Automobiles	0.3	2.5	1.0	2.4	7.7	8.6	19.6	15.7	22.4	19.8	100
OthVeicSpare	0.3	2.5	1.0	2.4	7.7	8.6	19.6	15.7	22.4	19.8	100
WoodFurnit	8.2	11.7	6.6	8.8	12.4	11.9	16.6	9.3	9.6	5.0	100
PaperGraph	2.3	7.8	3.7	6.2	8.4	8.1	18.7	13.0	16.7	15.1	100
RubberInd	0.8	4.7	3.2	4.6	14.4	5.5	24.0	13.6	16.6	12.5	100
ChemicElem	2.1	7.8	3.0	4.2	9.1	11.8	14.2	15.6	16.4	15.8	100
PetrolRefin	0.5	1.5	2.7	0.3	9.0	5.7	13.1	7.2	10.5	49.5	100
VariousChem	0.0	6.8	9.6	13.4	25.3	0.0	14.5	2.8	7.9	19.7	100
PharmacPerf	1.7	5.7	3.1	6.8	4.1	7.5	13.5	11.3	18.7	27.4	100
Plastics	1.6	6.3	2.3	8.5	12.8	12.1	24.6	10.3	9.0	12.6	100
Textiles	14.7	9.0	4.9	7.2	12.5	11.0	17.6	11.3	6.2	5.5	100
Apparel	3.2	17.3	7.5	15.1	16.1	9.7	15.7	5.4	4.5	5.5	100
ShoesInd	4.1	16.2	6.5	13.5	18.2	13.0	14.4	5.7	4.8	3.6	100
CoffeeInd	8.6	14.3	6.1	9.6	13.2	11.3	15.1	8.3	7.4	6.0	100
VegetProcess	8.6	14.3	6.1	9.6	13.2	11.3	15.1	8.3	7.4	6.0	100
Slaughter	8.6	14.3	6.1	9.6	13.2	11.3	15.1	8.3	7.4	6.0	100
Dairy	8.6	14.3	6.1	9.6	13.2	11.3	15.1	8.3	7.4	6.0	100
SugarInd	8.6	14.3	6.1	9.6	13.2	11.3	15.1	8.3	7.4	6.0	100
VegetOils	8.6	14.3	6.1	9.6	13.2	11.3	15.1	8.3	7.4	6.0	100
OthFood	8.6	14.3	6.1	9.6	13.2	11.3	15.1	8.3	7.4	6.0	100
VariousInd	16.8	13.4	6.6	6.2	11.4	7.4	13.1	7.8	10.7	6.5	100
PubUtilServ	1.7	17.5	5.3	8.6	7.1	6.0	12.9	12.2	14.2	14.5	100
CivilConst	6.3	13.4	8.6	10.1	12.5	9.0	20.2	9.6	6.9	3.4	100
Trade	10.0	14.2	6.6	8.2	10.7	8.2	15.1	8.3	10.0	8.7	100
Transport	4.6	7.0	4.4	4.7	7.5	7.1	19.0	16.1	18.1	11.6	100
Comunic	1.4	4.6	2.4	5.1	7.9	9.4	18.6	13.9	17.2	19.4	100
FinancInst	0.9	3.5	1.3	3.5	6.6	4.2	10.0	11.8	23.3	34.9	100
FamServic	16.4	20.3	7.4	8.4	9.6	6.8	12.1	6.5	7.2	5.4	100
EnterpServ	2.9	8.1	4.3	5.7	8.1	6.4	13.0	8.6	15.7	27.2	100
BuildRentals	2.0	4.3	2.7	4.8	9.9	6.3	17.1	8.8	18.4	25.7	100
PublAdm	1.7	13.1	3.6	7.2	7.6	6.8	13.0	12.1	19.3	15.6	100
NMercPriSer	7.6	16.6	6.0	9.2	9.3	10.9	13.7	8.2	11.6	6.9	100

**Table 5. Share of each activity in total labor bill, by occupation.**

Sectors	OCCUPATIONS (WAGE CLASS)									
	1	2	3	4	5	6	7	8	9	10



**Table 6. Wage bill distribution according to occupational wages and household income classes. 2001  
million Reais.**

Household income classes	OCC1	OCC2	OCC3	OCC4	OCC5	OCC6	OCC7	OCC8	OCC9	OCC10	Total
POF[1]	1535	1651	0	0	0	0	0	0	0	0	3187
POF[2]	523	2371	1635	848	0	0	0	0	0	0	5376
POF[3]	1814	4021	1194	2398	4321	3734	345	0	0	0	17828
POF[4]	758	1498	878	1412	1045	601	5080	0	0	0	11272
POF[5]	955	2808	1136	1646	2793	2307	5966	3313	0	0	20923
POF[6]	523	1807	795	1384	2121	2078	4242	5729	404	0	19085
POF[7]	577	2315	1180	2012	3036	3097	8717	7631	12809	0	41375
POF[8]	200	1137	526	1039	1826	1978	4883	5613	13198	1427	31828
POF[9]	122	693	399	762	1311	1454	4566	5221	15877	17010	47414
POF[10]	83	526	298	575	1132	1178	3934	5077	18441	134476	165721
Total	7090	18826	8040	12076	17585	16429	37733	32585	60730	152913	364008

**Table 7. Brazilian external trade structure.**

EXTERNAL TRADE						
	Armington elasticities (from Linkage model)	Share in total Brazilian exports	Exported share of total output	Imported share in local markets	Share in total imports	Capital/ Labor ratio
Coffee	6.50	0.00	0.00	0.00	0.00	0.72
SugarCane	5.40	0.00	0.00	0.00	0.00	0.72
PaddyRice	10.10	0.00	0.00	0.02	0.00	0.72
Wheat	8.90	0.00	0.00	0.72	0.01	0.72
Soybean	4.90	0.03	0.38	0.03	0.00	0.72
Cotton	5.00	0.00	0.00	0.00	0.00	0.72
Corn	2.60	0.01	0.16	0.02	0.00	0.72
Livestock	3.89	0.00	0.00	0.00	0.00	0.72
NaturMilk	7.30	0.00	0.00	0.00	0.00	0.72
Poultry	2.60	0.00	0.00	0.01	0.00	0.72
OtherAgric	3.70	0.02	0.03	0.02	0.01	0.72
MineralExtr	1.80	0.04	0.56	0.07	0.01	0.92
PetrGasExtr	10.40	0.01	0.05	0.24	0.06	14.01
MinNonMet	5.80	0.01	0.07	0.04	0.01	1.62
IronProduc	5.90	0.04	0.16	0.05	0.01	7.18
MetalNonFerr	8.40	0.03	0.19	0.12	0.02	3.80
OtherMetal	7.50	0.02	0.07	0.08	0.02	0.26
MachTractor	8.60	0.03	0.10	0.22	0.08	1.93
EletricMat	8.10	0.02	0.14	0.29	0.05	0.68
EletronEquip	8.80	0.03	0.36	0.56	0.10	2.15
Automobiles	5.60	0.05	0.23	0.14	0.03	2.03
OthVeicSpare	8.60	0.09	0.41	0.25	0.07	0.75
WoodFurnit	6.80	0.03	0.21	0.03	0.00	0.53
PaperGraph	5.90	0.03	0.11	0.05	0.01	1.20
RubberInd	6.60	0.01	0.12	0.13	0.01	3.31
ChemicElem	6.60	0.01	0.10	0.18	0.03	6.84
PetrolRefin	4.20	0.05	0.07	0.13	0.10	21.68
VariousChem	6.60	0.01	0.06	0.17	0.04	1.22
PharmacPerf	6.60	0.01	0.05	0.25	0.04	1.65
Plastics	6.60	0.01	0.06	0.11	0.01	0.51
Textiles	7.50	0.02	0.10	0.10	0.02	0.56
Apparel	7.40	0.00	0.02	0.02	0.00	0.39
ShoesInd	8.10	0.04	0.63	0.07	0.00	1.31
CoffeeInd	2.30	0.02	0.22	0.00	0.00	3.77
VegetProcess	4.01	0.03	0.14	0.04	0.01	0.95
Slaughter	8.42	0.04	0.16	0.01	0.00	1.36
Dairy	7.30	0.00	0.01	0.03	0.00	2.17
SugarInd	5.40	0.03	0.37	0.00	0.00	3.50
VegetOils	6.60	0.04	0.29	0.02	0.00	5.53
OthFood	3.81	0.02	0.08	0.05	0.01	0.88
VariousInd	7.50	0.01	0.12	0.23	0.02	1.89
PubUtilServ	5.60	0.00	0.00	0.03	0.01	1.77
CivilConst	3.80	0.00	0.00	0.00	0.00	4.09
Trade	3.80	0.01	0.03	0.04	0.01	0.16
Transport	3.80	0.06	0.14	0.10	0.04	0.04

Comunic	3.80	0.00	0.01	0.01	0.00	1.90
FinancInst	3.80	0.01	0.01	0.02	0.01	0.38
FamServic	3.80	0.03	0.04	0.07	0.05	0.10
EnterpServ	3.80	0.06	0.15	0.18	0.09	0.44
BuildRentals	3.80	0.00	0.00	0.00	0.00	46.46
PublAdm	3.80	0.01	0.01	0.01	0.02	0.00
NMercPriSer	3.80	0.00	0.00	0.00	0.00	0.00

**Table 8. Shocks to the CGE model (% change shocks).**

	Import tariffs	Import CIF prices	Implied export prices shifts*
Coffee	0	0.03	10.05
SugarCane	0	0	0
PaddyRice	-0.01	4.80	0
Wheat	-0.28	-2.76	9.30
Soybean	0	1.45	2.24
Cotton	0	14.44	8.18
Corn	-0.01	-3.30	16.17
Livestock	0	1.14	-9.29
NaturMilk	0	0	0
Poultry	-0.04	0.03	-11.49
OtherAgric	-2.50	2.17	4.49
MineralExtr	-1.68	-2.55	-10.19
PetrGasExtr	-0.03	-2.55	-10.19
MinNonMet	-5.53	0.57	-0.72
IronProduc	-5.22	0.57	-0.72
MetalNonFerr	-4.50	0.57	-0.72
OtherMetal	-8.42	0.57	-0.72
MachTractor	-7.38	0.57	-0.72
EletricMat	-7.48	0.57	-0.72
EletronEquip	-6.42	0.57	-0.72
Automobiles	-7.79	0.57	-0.72
OthVeicSpare	-5.51	0.57	-0.72
WoodFurnit	-7.40	0.57	-0.72
PaperGraph	-3.57	0.57	-0.72
RubberInd	-8.41	0.57	-0.72
ChemicElem	-4.90	0.57	-0.72
PetrolRefin	-2.96	0.57	-0.72
VariousChem	-5.83	0.57	-0.72
PharmacPerf	-4.49	0.57	-0.72
Plastics	-9.53	0.57	-0.72
Textiles	-11.39	0.11	1.18
Apparel	-12.35	0.11	1.18
ShoesInd	-6.07	0.11	1.18
CoffeeInd	-1.47	7.32	25.50
VegetProcess	-2.81	5.93	25.37
Slaughter	-1.79	3.67	25.37
Dairy	-2.67	10.45	38.92
SugarInd	-0.73	0	25.30
VegetOils	-4.50	-0.79	-1.33
OthFood	-5.05	7.32	25.50
VariousInd	-7.18	0.57	-0.72
PubUtilServ	0	-0.21	-0.68
CivilConst	0	-0.21	-0.68
Trade	-1.77	-0.21	-0.68
Transport	-0.00	-0.21	-0.68
Comunic	-1.21	-0.21	-0.68
FinancInst	0	-0.21	-0.68
FamServic	-0.05	-0.21	-0.68
EnterpServ	0	-0.21	-0.68
BuildRentals	0	-0.21	-0.68
PublAdm	-1.50	-0.21	-0.68
NMercPriSer	0	-0.21	-0.68

\* Vertical shift in export demand schedule calculated from Linkage results.



**Table 9. Shocks to the production tax rates for agriculture and lightly processed foods sectors.**

Sector	Level shocks*
1 Agriculture	0.007
2 Slaughter	-0.046
3 Dairy	-0.047
4 SugarInd	-0.048
5 VegetOils	-0.046

**Table 10. Percentage change in selected macroeconomic results.**

Macros	percentage changes
Real Household Consumption	0.66
Real Investment	0.14
Real Government Expenditure	0
Exports Volume	5.29
Imports Volume	7.92
Real GDP	0.10
Aggregate Employment	0.00
Average real wage	1.28
Aggregated Capital Stock	0
GDP Price Index	0.13
Consumer Price Index	0.00
Exports Price Index	-0.68
Imports Price Index	-3.37
Nominal GDP	0.22
Nominal Land Price	28.0

**Table 11. Activity level variation by industry. Percentage changes.**

<b>Industry</b>	<b>Percentage change</b>
Agriculture	7.51
MineralExtr	-12.06
PetrGasExtr	-4.17
MinNonMet	-2.63
IronProduc	-9.40
MetalNonFerr	-11.77
OtherMetal	-6.85
MachTractor	-6.55
ElectricMat	-5.83
ElectronEquip	-4.75
Automobiles	0.76
OthVehSpare	-11.65
WoodFurnit	-5.51
PaperGraph	-2.82
RubberInd	-8.57
ChemElem	-11.93
PetrolRefin	-1.28
VariousChem	-1.64
PharmacPerf	-0.19
Plastics	-4.97
Textiles	-2.88
Apparel	0.43
ShoesInd	-12.83
CoffeeInd	14.31
VegetProcess	15.05
Slaughter	19.03
Dairy	7.89
SugarInd	59.60
VegetOils	4.54
OthFood	8.57
VariousInd	-7.80
PubUtilServ	-1.08
CivilConst	-0.01
Trade	1.19
Transport	0.24

Comunic	0.21
FinancInst	-0.34
FamService	-1.54
EnterpServ	-2.90
BuildRentals	-0.19
PublAdm	-0.18
NMercPriSer	-0.77

**Table 12. Regional results, 27 regions. Percentage changes, Brazil, 2001.**

Region	Macro region	Real GDP	Aggregate Employment	Nominal GDP
Rondonia	N	3.17	1.54	6.32
Acre	N	2.85	1.32	6.49
Amazonas	N	-0.46	-0.51	-0.45
Roraima	N	1.83	0.77	3.87
Para	N	2.05	1.12	4.63
Amapa	N	1.49	0.74	4.81
Tocantins	N	3.58	2.33	6.97
Maranhao	NE	3.62	2.15	6.93
Piaui	NE	2.33	1.25	4.19
Ceara	NE	0.23	0.04	0.65
RGNorte	NE	-0.55	-0.17	-1.39
Paraiba	NE	1.57	0.71	3.28
Pernambuco	NE	1.12	0.54	1.9
Alagoas	NE	5.87	2.91	7.99
Sergipe	NE	0.36	0.23	0.71
Bahia	NE	0.33	0.22	1.02
MinasG	SE	0.45	0.21	1.22
EspSanto	SE	0.41	0.12	1.4
RioJaneiro	SE	-1.43	-0.95	-2.54
SaoPaulo	SE	-0.53	-0.49	-1.19
Parana	S	1.78	0.99	3.46
StaCatari	S	0.50	0.68	0.55
RGSul	S	0.07	0.11	0.70
MtGrSul	CW	5.15	3.1	9.85
MtGrosso	CW	4.84	2.95	10.12
Goias	CW	2.87	1.78	5.35
DF	CW	0	-0.01	0.25

**Table 13. Average household income, Consumer Price Index (CPI) by household income class, and GINI index. Percentage change.**

Household Income class	Average income	Consumer Price Index
1 POF[1]	34.47	0.48
2 POF[2]	7.70	0.42
3 POF[3]	4.84	0.35
4 POF[4]	2.74	0.24
5 POF[5]	1.64	0.22
6 POF[6]	0.52	0.19
7 POF[7]	-0.38	0.10
8 POF[8]	-1.23	0.03
9 POF[9]	-1.66	-0.12
10 POF[10]	-2.37	-0.36
GINI Index	-1. 7	

**Table 14. Percentage changes in the number of poor households (FGT0) and of the poverty gap ratio (FGT1) by household income groups.**

Household income class	FGT0	FGT1
1 POF[1]	-2.73	-8.32
2 POF[2]	-3.06	-9.44
3 POF[3]	-5.62	-9.35
4 POF[4]	-6.67	-3.51
5 POF[5]	-4.46	9.55
6 POF[6]	7.32	53.91
7 POF[7]	56.49	313.48
8 POF[8]	470.41	2032.72
9 POF[9]	0	0
10 POF[10]	0	0
Original values (base year)	0.308	0.145
Percentage change	-3.45	-7.59

FGT0: Foster-Greer-Torbecke proportion of poor households index, or headcount ratio. FGT1: poverty gap ratio.

**Table 15. Percentage changes in the headcount ratio (FGT0) and in the average gap (FGT1) by region, and total number change.**

Region	FGT0 (% change)	FGT1 (% change)
1 Rondonia	-6.29	-7.88
2 Acre	-4.47	-8.50
3 Amazonas	0.07	-0.94
4 Roraima	-5.37	-7.38
5 Para	-4.28	-7.54
6 Amapa	-0.56	-2.32
7 Tocantins	-9.47	-15.55
8 Maranhao	-5.36	-14.18
9 Piaui	-4.21	-8.36
10 Ceara	-2.59	-6.51
11 RGNorte	-3.28	-6.13
12 Paraiba	-4.49	-9.33
13 Pernambuco	-4.54	-9.18
14 Alagoas	-6.90	-14.77
15 Sergipe	-3.59	-6.90
16 Bahia	-2.77	-7.72
17 MinasG	-5.05	-9.18
18 EspSanto	-4.49	-10.68
19 RioJaneiro	2.90	1.90
20 SaoPaulo	1.85	-0.75
21 Parana	-7.07	-11.13
22 StaCatari	-3.94	-6.94
23 RGSul	-6.19	-10.31
24 MtGrSul	-14.29	-19.41
25 MtGrosso	-10.07	-21.34
26 Goias	-8.55	-13.92
27 DF	-0.30	-1.69
		Total number
Change in total number of poor households		-533,179
Change in total number of poor persons		-1,944,666