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Agricultural Trade Liberalization and Poverty in Brazil

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Markets, Trade, and Institutions Division

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ABSTRACT

This paper addresses the potential effects of a world agricultural trade liberalization scenario on poverty and regional income distribution in Brazil, using an interregional applied general equilibrium (AGE) and microsimulation model of Brazil, tailored for income distribution and poverty analysis. The model distinguishes 10 different labor types and 270 different household expenditure patterns. Income can originate from 41 different production activities (which produce 52 commodities), located in 27 states in the country. The AGE model is linked to a microsimulation model that includes 112,055 Brazilian households and 263,938 adults.

The scenario is generated from a previous run of the MIRAGE model, which assesses the likely impacts of a Doha Development Agenda agreement, based on the draft on agriculture by Crawford Falconer and the draft on nonagricultural market access by Don Stephenson. The results of this global scenario are transmitted to the Brazilian model. Poverty and income distribution indexes are computed over the entire sample of households and persons, before and after the introduction of policy shocks. Model results show that the simulated trade policy shocks have positive effects on poverty and income distribution in Brazil. The simulated effects on poverty and income distribution are positive in aggregate, with benefits concentrated in the poorest households. The results, however, differ across the Brazilian territory, worsening in some important states, where the poverty and inequality indicators increase. The gains in agriculture are found to benefit all the agents involved, from workers to small producers to large farmers, rejecting the idea that just large farmers would gain.

Keywords: economic integration, poverty, income distribution, Brazil

1. INTRODUCTION

The resilience of the income distribution concentration in Brazil has attracted the attention of researchers both inside and outside the country. Despite the slight improvement in the situation in recent years, due mainly to direct transfer policies implemented by the federal government, income inequality remains one of the most serious problems in Brazil's society. There is a growing perception that increasing world trade offers many opportunities for the Brazilian economy to grow. How much will such growth benefit the poor, however, is unclear. This paper is an effort to provide a quantitative 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 comparison of effects between Brazil's 26 states and the Federal District[1].

The next section describes the poverty and income distribution figures in Brazil in the base year and briefly reviews the recent literature on the topic. Then the methodological approach to be pursued here is introduced and the model itself is presented, along with a discussion of its main aspects and the database. Finally, results and conclusions are shown.

[1] Throughout the text the designation "state" will be used for the 26 states plus the Federal District, for simplicity.

2. POVERTY AND INCOME DISTRIBUTION EVOLUTION IN BRAZIL: AN OVERVIEW

It has long been recognized that Brazil, although a country with a large number of poor persons, is not a very poor country[2]. According to a study by Barros, Corseuil, and Cury (2001), based on the 1999 Report on Human Development (United Nations Development Program, 1999) 77 percent of the world's people (and 64 percent of nations) have average incomes lower than Brazil's. However, because income distribution in Brazil is particularly uneven, about 30 percent of Brazilians are poor, a figure that would be just 8 percent if Brazil's income were distributed as in other countries with similar per capita income.

The same authors show that in 1999 about 14 percent of the Brazilian population lived in households with incomes below the line of extreme poverty—the indigence line (about 22 million people), and 34 percent of the population lived in households with incomes below the poverty line (about 53 million people). Even though the percentage of poor in the population declined from 40 percent in 1977 to 34 percent in 1999, this level is still very high. The extent of poverty in Brazil, measured both as a percentage of the population and in terms of a poverty gap, stabilized in the second half of the 1980s, although at a lower level than was observed in the previous period. It started to improve in 2001, in part due to transfer programs implemented by the federal government.

Brazilian poverty also has an important regional dimension. The richer South-East region of the country, which accounted for 43 percent of the total population in 2001, had only 31 percent of the poor. The same pattern could be observed in the South region, with 15 percent of the population and 10 percent of the poor. In the North and Center-West regions, the share of the population and of the poor is about the same, 11 and 12 percent, respectively, for the North and 7 and 6 percent for the Center-West. In the poorest region of the country, the Northeast, the region's share of population is lower than its share of the poor: 25.0 and 41.0 percent, respectively. This regional dimension of poverty is presently an important and sensitive political issue in Brazil.

Green, Dickerson, and Arbache (2001) analyze the behavior of wages and the allocation of labor throughout the 1980–99 trade liberalization period in Brazil. The authors point out that wage inequality remained fairly constant throughout the 1980s and 1990s, except for a small peak in the mid-1980s. The main conclusion of the study is that the egalitarian consequences of trade liberalization were not important in Brazil during the period analyzed. As caveats, the authors note the low trade exposure of the Brazilian economy (about 13 percent in 1997), as well as the small share of workers that have completed college studies (1 in 12 workers at that time).

The degree of openness of the Brazilian economy has steadily increased since then. The new trading opportunities that arose in the 1990s, as well as the potential for further improvements under the Doha Round, can provide new means for poverty alleviation and inequality reductions in the country to continue. Assessing these effects is the main objective of this research.

[2] This section is based on Ferreira Fo and Horridge (2005).

3. METHODOLOGY

Although computable general equilibrium (CGE) models have long been used for poverty analysis, many have employed a single representative household to represent consumer behavior. This limits the scope for income distribution and poverty analysis, since no intragroup income distribution changes can be shown. The CGE model used in this study, the TERM-BR model, is a static interregional model of Brazil, based on the TERM[3] 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.

Each region has a complete specification of a standard CGE structure. Each industry and final demander combines Brazilian and imported versions of each commodity to produce a user-specific constant elasticity of substitution (CES) composite good. Household consumption of these domestic and 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") sector distributes its output (according to a constant elasticity of transformation - constraint) among 11 agricultural commodities. Export volumes are determined by constant-elasticity[4] foreign demand schedules.

These regional CGE models are linked by trade in goods through trade matrixes that record, for each commodity, source and destination region, the values of Brazilian and foreign goods transported, as well as the associated transport or trade margins.[5] These trade matrixes were estimated using information about regional production, regional consumption, and a gravitational type method. Users of any particular good in São Paulo, for example, substitute between the same good produced in the 27 states according to their relative prices under a CES demand system.[6] The model is solved with the GEMPACK software. The CGE model is calibrated with data from two main sources: the 2001 Brazilian Input–Output Matrix (http://ibge.gov.br) [7] and the Brazilian Agricultural Census (IBGE 1996a).

On the income generation side of the model, workers are divided into 10 different categories (occupations), according to their wages, as a proxy for skills. These wage classes are then assigned to each regional industry in the model. Together with the revenues from other endowments (capital, land rents, and natural resources 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, which drives changes in poverty and income distribution. Using the expenditure survey data, the CGE model is extended to cover 270 different expenditure patterns, composed of 10 different income groups in 27 regions. In this way, all the expenditure-side detail of the microsimulation dataset is incorporated within the main CGE model.

The two main sources of information for the household microsimulation model are the Pesquisa Nacional por Amostragem de Domicílios (PNAD or National Household Survey) (IBGE 2001), and the Pesquisa de Orçamentos Familiares (POF or Household Expenditure Survey) (IBGE 1996b). The PNAD contains information about households and persons and includes a total of 331,263 records. The main information extracted from PNAD is wage by industry and region, as well as other personal socioeconomic characteristics such as years of schooling, sex, age, and position in the family.

[3] Versions of the TERM model have been prepared for Australia, Brazil, China, Finland, Indonesia, and Japan. Related material can be found at www.monash.edu.au/policy/term.htm.

[4] For the simulations reported here, we set the export demand elasticities to values derived from the Global Trade Analysis Project (GTAP) model, so as to increase consistency between results for the world and Brazil models.

[5] The dimensions of this margins matrix are 52x2x2x27x27.

[6] For most goods, the interregional elasticity of substitution is fairly high. To ease the computational burden, the assumption is that all users of good G in region R draw the same share of their demands from region Z.

[7] 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.

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 is the expenditure patterns of 10 different income groups for the 11 regions. One such pattern was assigned to each individual PNAD household, according to each income group. 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 only includes information about urban areas (the metropolitan areas of the main state capitals).

Model Running Procedures and Highlights

As mentioned before, the model consists of two main parts: a CGE model and a household microsimulation model (MS). The models are run sequentially. To ensure consistency between the two models, the CGE model is sufficiently detailed; its categories and data are close enough to those of the MS model that the CGE model closely predicts MS behavior (for categories that are also included in the CGE model, such as household demand or labor supplies). Note that each household in the micro data set has 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. Actually, the MS model is constrained to give the same consumption vector as the CGE model. The role of the MS model is to provide extra information, about the variance of income within income groups, for example, 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.

The simulation starts with a set of trade shocks generated by a MIRAGE model scenario simulation, to be described below. These shocks consist of changes in import prices and in export demands, to which shocks to import tariffs in Brazil (the Brazilian part of the trade liberalization scenario) are added. 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 among the 27 states. Next, the results from the CGE model are used to update the MS model, updating wages and hours worked for the 263,938 workers in the sample, as well as job relocations. These changes have a regional (27 states) as well as sectoral (42 industries) dimension.

The job relocation process is implemented by changing the PNAD weight of each worker (see Ferreira Fo 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, a true job relocation process is incorporated. Although this job relocation has very little effect on the distribution of wages among the 270 household groups identified by the CGE model, it may have considerable impact on the variance of income within a group.

And, finally, 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 and computed by household. This is possible since the PNAD survey provides a link from persons to households that 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 an important methodological detail, since it is likely that family income variations are cushioned, in general, by this procedure. If, for example, one person in a household loses his job but another in the same household gets a new job, household income may change little. Since households are the expenditure units in the model, we would expect, on the one hand, 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: POVERTY AND INCOME DISTRIBUTION IN BRAZIL IN 2001

In this section, the description of poverty and income inequality in Brazil is extended to show in detail the situation in the year 2001, which is the base for this analysis. Some general aggregated information about poverty and income inequality in Brazil can be seen in Table 1.

The rows of Table 1 correspond to household income groups, classified according to POF definitions,[8] such that POF[1] is the lowest income group and POF[10] the highest. A fair picture of income inequality in Brazil emerges from the table. On the one hand, we see that the first five income groups, while accounting for 52.6 percent of the total population in Brazil, receive only 17 percent of total income. The highest income group, on the other hand, accounts for 11 percent of population and about 45 percent of total income. The Gini index associated with income distribution in Brazil in 2001, calculated using an equivalent household basis[9], is 0.58, placing Brazil's income distribution among the world's worst.

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	---	---	---	---	---

Source: IBGE 2001.
Notes: 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 group.

The unemployment rate is also relatively higher among the poorer groups. This is an important point, due to its relevance for poverty modeling. The opportunity to get a new job is probably the main ingredient for lifting people out of poverty: hence it is important for the model to include a switching mechanism to capture a move from unemployment to employment and vice versa, and not just changes in

[8] POF[1] ranges from 0 to 2 times the minimum wage, POF[2] from 2+ to 3, POF[3] from 3+ to 5, POF[4] from 5+ to 6, POF[5] from 6 to 8, POF[6] from 8 to 10, POF[7] from 10 to 15, POF[8] from 15 to 20, POF[9] from 20 to 30, and POF[10] more than 30 times the minimum wage. The minimum wage in Brazil in 2001 was about US$76 per month.

[9] The equivalent household concept measures the subsistence needs of a household by attributing weights to its members: 1.00 to the head, 0.75 to other adults, and 0.50 to children (considering that it does not cost double to feed two persons). Because poverty is defined here on an equivalent basis, only a few very large families in middle-incomes groups fall below the poverty line.

wages. As can be seen in Table 1, the unemployment rate reaches 36.5 percent among the lowest income group (persons more than 15 years of age) and just 7.7 percent among the richest. The percentage of white people also increases considerably with household income, while the share of children in the population 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.[10] According to that criterion, 30.8 percent of the Brazilian households in 2001 would be poor.[11] The poor would comprise 96.2 percent, 76.6 percent, and 53.5 percent, respectively, of households in the first three income groups,[12] 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 (1984) (FGT, for short) overall measures of poverty: FGT0 is the proportion of poor households (those below the poverty line), FGT1 is the average poverty gap ratio (the proportion by which household income falls below the poverty line), and FGT2 is a measure of inequality *among* the poor. As can be seen in Table 2, the average poverty gap is large for the two lowest income groups. Together these two income groups contribute to about half of the general average poverty gap index of the economy. The first income group, for example, falls below the poverty line by about 70 percent. Thus, large income increases for the poor are needed to significantly change the number in poverty.

Table 2. POF group contributions to Foster-Greer-Thorbecke poverty indexes

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	0.0390	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

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

[10] This poverty line was equivalent to US$48.00 in 2001.

[11] Barros, Henriques, and Mendonça (2001), working with a poverty line that takes into account nutritional needs, find that 34 percent of the Brazilian households were poor in 1999.

[12] The proportion of households below the poverty line in the other income groups are 0.284 percent for the 4th, 0.14 percent for the 5th, 0.04 percent for the 6th, 0.008 percent for the 7th, and 0.001 percent for the 8th. There are no households below the poverty line in the two highest income groups.

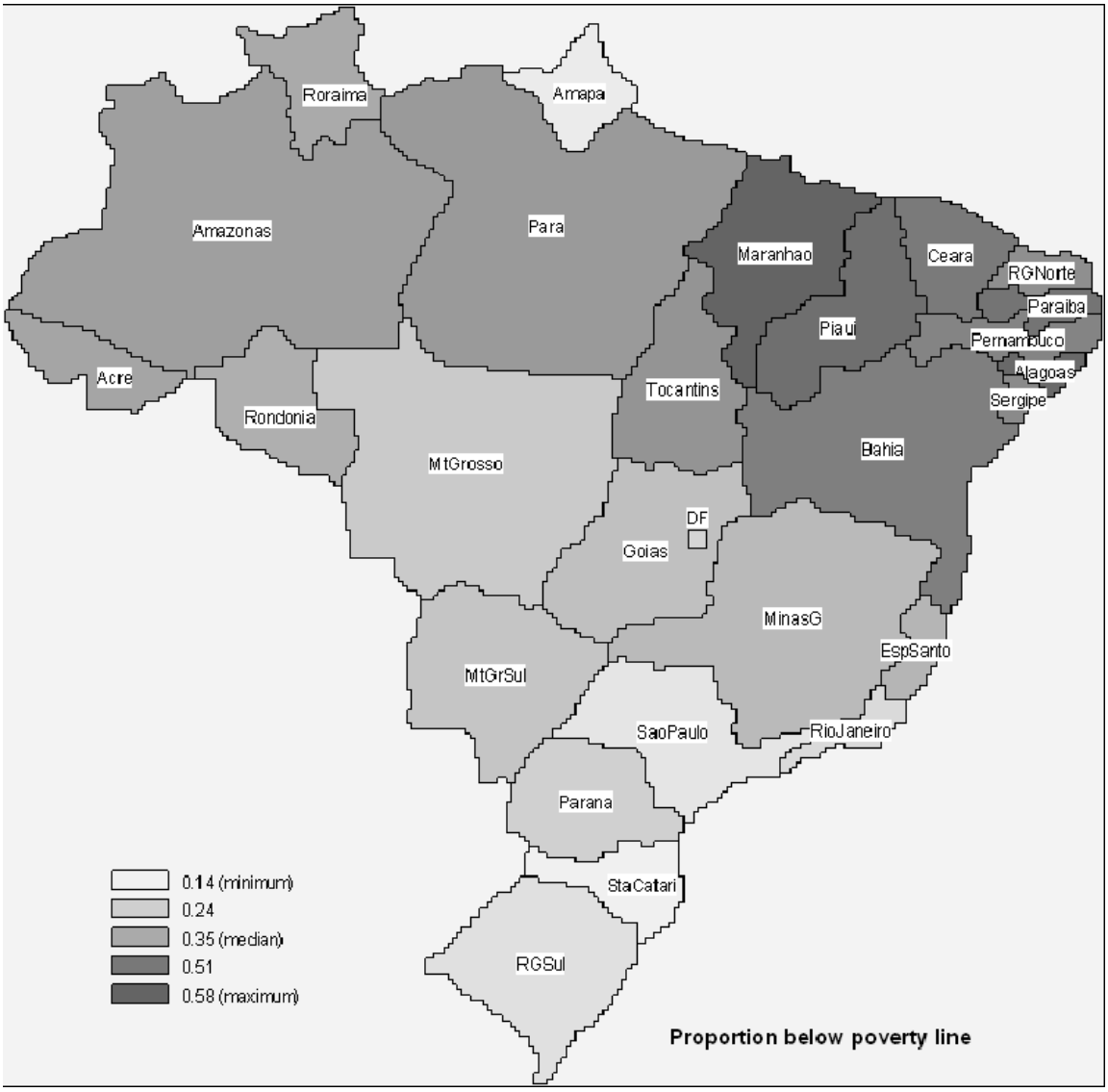
As stated before, this general poverty and inequality picture also has an important regional dimension in Brazil, given that economic activity is located mainly in the South-East region. This is particularly true of manufacturing; agriculture is more dispersed among regions. Table 3 presents more information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

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

State	Region[a]	Population share of each state	Proportion of poor households in state population	Regional state contribution to the poverty gap	Regional state average poverty gap
Rondonia	N	0.005	0.338	0.001	0.147
Acre	N	0.002	0.356	0.000	0.176
Amazonas	N	0.011	0.396	0.002	0.196
Roraima	N	0.001	0.347	0.000	0.152
Para	N	0.023	0.425	0.005	0.194
Amapa	N	0.003	0.151	0.000	0.069
Tocantins	N	0.006	0.429	0.001	0.180
Maranhao	NE	0.029	0.579	0.008	0.288
Piaui	NE	0.015	0.564	0.005	0.304
Ceara	NE	0.042	0.540	0.011	0.267
RGNorte	NE	0.016	0.471	0.004	0.218
Paraiba	NE	0.019	0.550	0.005	0.257
Pernambuco	NE	0.045	0.512	0.011	0.248
Alagoas	NE	0.015	0.577	0.004	0.289
Sergipe	NE	0.010	0.503	0.002	0.239
Bahia	NE	0.073	0.520	0.019	0.256
MinasG	SE	0.108	0.301	0.014	0.133
EspSanto	SE	0.019	0.324	0.003	0.144
RioJaneiro	SE	0.095	0.202	0.009	0.095
SaoPaulo	SE	0.229	0.166	0.019	0.083
Parana	S	0.059	0.237	0.006	0.100
StaCatari	S	0.034	0.136	0.002	0.055
RGSul	S	0.067	0.179	0.005	0.073
MtGrSul	CW	0.013	0.289	0.002	0.120
MtGrosso	CW	0.015	0.251	0.002	0.106
Goias	CW	0.031	0.300	0.004	0.126
DF	CW	0.013	0.219	0.001	0.106
Total	**Brazil**	**1.000**	**0.308**	**0.145**	**0.145**

Notes: [a] N = North; NE = North-East; SE = South-East; S = South; CW = Center-West.

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



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

The states in the North (N) region in Table 3 account for 11 percent of total population, compared with 25 percent for the North-East (NE), 43 percent for the South-East (SE), 15 percent for the South (S), and 7 percent for the Center-West (CW). In the SE region, the state of São Paulo alone accounts for 22.9 percent of the total Brazilian population.

The fourth column in Table 3 shows the share of households below the poverty line in each state, 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, the state population is taken into account, the fifth column shows that the populous states of Bahia, Ceará, Minas Gerais, Pernambuco, and São Paulo score higher on the Foster-Greer-Thorbecke poverty gap index[13]. These figures are the

[13] The poverty gap and poverty line values are constructed with "adult equivalent" per capita household income.

contribution of each state to the total poverty gap index in Brazil expressed as a proportion of the poverty line (see the column total). We can see that the average poverty gap in Brazil in 2001 is 14.5 percent of the population with incomes below the poverty line.

The last column in Table 3 shows the state 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 region plus the states of Para and Tocantins showing the largest poverty gaps. Two states in the S region (Rio Grande do Sul and Santa Catarina) have the smallest poverty gaps in Brazil, followed closely by São Paulo. Although Amapa state (in the N region) has a poverty gap in line with that of the richer states of the S and SE, this result, should be viewed with caution, since that state has a very small share of the 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 is presented in Tables 4 and 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 groups and vice versa. As Table 4 shows, agriculture is the activity that uses the most unskilled labor (40.5 percent of that sector's labor bill), while petroleum and gas extraction and petroleum refineries are the most intensive users of skilled labor (10^{th} labor group), 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 the most unskilled labor in Brazil, about 41 percent of total workers in income group 1 (Table 5). The trade sector is the second largest employer of this type of labor. As for the higher income groups, the financial institution and public administration sectors hire the largest number of well-paid workers.

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

	OCCUPATIONS (WAGE GROUP)										
Sector	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
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

Table 4. Continued

	OCCUPATIONS (WAGE GROUP)										
Sector	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
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

Source: IBGE (2001).

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

	OCCUPATIONS (WAGE GROUP)									
Sector	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Agriculture	41.0	17.8	9.8	6.9	4.8	3.8	2.2	1.4	1.1	0.9
MineralExtr	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.2	0.1
PetrGasExtr	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.3	0.5
MinNonMet	0.5	0.8	0.9	0.8	0.8	1.0	0.6	0.5	0.3	0.2
IronProduc	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.3	0.3	0.2
MetalNonFerr	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1
OtherMetal	0.3	0.7	1.2	1.3	1.7	1.9	2.4	2.0	1.5	0.9
MachTractor	0.1	0.5	0.5	0.9	1.1	1.7	2.0	2.3	1.6	1.8
EletricMat	0.0	0.1	0.2	0.2	0.5	0.7	0.7	0.7	0.5	0.5
EletronEquip	0.0	0.1	0.2	0.2	0.4	0.6	0.5	0.5	0.4	0.4
Automobiles	0.0	0.1	0.1	0.1	0.3	0.4	0.5	0.5	0.5	0.5
OthVeicSpare	0.0	0.2	0.2	0.3	0.8	1.1	1.3	1.3	1.4	1.2
WoodFurnit	0.9	0.7	1.1	1.0	1.2	1.4	1.0	0.8	0.6	0.3

Table 5. Continued

	OCCUPATIONS (WAGE GROUP)									
Sector	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
PaperGraph	0.3	0.6	0.8	0.9	1.0	1.2	1.4	1.3	1.2	1.1
RubberInd	0.0	0.1	0.1	0.1	0.3	0.1	0.3	0.2	0.2	0.1
ChemicElem	0.1	0.1	0.2	0.1	0.3	0.4	0.3	0.4	0.3	0.3
PetrolRefin	0.0	0.1	0.3	0.0	0.5	0.4	0.5	0.3	0.4	1.7
VariousChem	0.0	0.3	1.1	1.0	1.6	0.0	0.6	0.2	0.3	0.8
PharmacPerf	0.1	0.2	0.3	0.4	0.2	0.5	0.5	0.5	0.6	0.9
Plastics	0.1	0.2	0.2	0.5	0.6	0.7	0.8	0.4	0.3	0.4
Textiles	0.7	0.2	0.4	0.4	0.5	0.6	0.5	0.4	0.2	0.1
Apparel	0.3	0.9	1.1	1.5	1.3	1.0	0.8	0.4	0.2	0.3
ShoesInd	0.2	0.4	0.4	0.6	0.7	0.6	0.3	0.2	0.1	0.1
CoffeeInd	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
VegetProcess	0.5	0.4	0.5	0.6	0.6	0.7	0.5	0.3	0.2	0.2
Slaughter	0.4	0.3	0.4	0.5	0.5	0.5	0.4	0.3	0.2	0.1
Dairy	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.0
SugarInd	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1
VegetOils	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
OthFood	1.0	1.0	1.2	1.2	1.4	1.5	1.0	0.7	0.5	0.4
VariousInd	0.7	0.3	0.5	0.3	0.5	0.4	0.3	0.3	0.3	0.2
PubUtilServ	0.5	3.2	2.8	3.0	2.0	2.1	2.4	3.0	2.5	2.6
CivilConst	2.7	3.3	6.1	4.8	4.9	4.3	5.0	3.2	1.6	0.8
Trade	13.5	11.2	14.8	12.6	13.3	12.5	12.0	8.7	7.5	6.6
Transport	2.6	2.3	4.1	3.0	3.8	4.4	6.2	7.0	5.6	3.6
Comunic	0.2	0.4	0.6	0.8	1.0	1.5	1.6	1.6	1.4	1.6
FinancInst	1.0	2.3	2.4	4.4	6.9	5.3	6.7	10.5	14.6	22.3
FamServic	21.0	15.1	15.8	12.1	11.2	9.8	9.0	6.5	5.1	3.9
EnterpServ	1.6	2.6	4.0	3.6	4.1	4.0	4.2	3.8	4.8	8.5
BuildRentals	0.1	0.2	0.3	0.3	0.6	0.4	0.6	0.4	0.6	0.9
PublAdm	6.4	29.4	23.3	31.2	26.7	29.3	29.2	36.3	40.8	33.7
NMercPriSer	2.2	2.8	2.9	3.0	2.4	3.5	2.3	1.8	1.8	1.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: IBGE (2001).

Table 6 shows the distribution of occupational wages (OCC) groups among the household income groups (POF classes). In this table, the rows show household income groups, 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 8th income class and above. We see, then, that the household income classes are highly positively correlated with the occupational wage earning classes.

Table 6. Wage bill distribution according to occupational wages and household income groups, 2001 (million Reais)

Household income group	OCC1	OCC2	OCC3	OCC4	OCC5	OCC6	OCC7	OCC8	OCC9	OCC10	Total
POF[1]	1,535	1,651	0	0	0	0	0	0	0	0	3,187
POF[2]	523	2,371	1,635	848	0	0	0	0	0	0	5,376
POF[3]	1,814	4,021	1,194	2,398	4,321	3,734	345	0	0	0	17,828
POF[4]	758	1,498	878	1,412	1,045	601	5,080	0	0	0	11,272
POF[5]	955	2,808	1,136	1,646	2,793	2,307	5,966	3,313	0	0	20,923
POF[6]	523	1,807	795	1,384	2,121	2,078	4,242	5,729	404	0	19,085
POF[7]	577	2,315	1,180	2,012	3,036	3,097	8,717	7,631	12,809	0	41,375
POF[8]	200	1,137	526	1,039	1,826	1,978	4,883	5,613	13,198	1,427	31,828
POF[9]	122	693	399	762	1,311	1,454	4,566	5,221	15,877	17,010	47,414
POF[10]	83	526	298	575	1,132	1,178	3,934	5,077	18,441	134,476	165,721
Total	7,090	18,826	8,040	12,076	17,585	16,429	37,733	32,585	60,730	152,913	364,008

Source: IBGE 1996b.

Notes: The *Pesquisa de OrcamentaosFamiliares* (POF) number indicates the household expenditure group; OCC is the occupational wage group.

The composition of income within agriculture, according to the type of worker, is presented in Table 7. In the table, workers in agriculture are classified as permanent workers—workers who have a stable working relationship on a farm; temporary workers, who are hired on a daily basis; self-employed workers, who have no working relationship with an employer and either exploit their own land or rented land; and employers, who are farmers who employ workers other than from its own family. Temporary workers tend to be concentrated in the lower household expenditure groups, compared with permanent workers: the share of income of temporary workers in the first four income groups is 0.58, a value that falls to 0.44 in the case of permanent workers. The self-employed tend to be concentrated in households in the intermediate groups, with a share of 0.45 of their income in groups 5 to 7, and employers are mainly found in the highest income group. This situation, of course, is not homogeneous across regions, as will be seen later.

Table 7. Income composition within agriculture by type of employment, Brazil, 2001

Household group	Permanent	Temporary	Self-employed	Employer
POF[1]	0.036	0.132	0.040	0.002
POF[2]	0.082	0.096	0.032	0.003
POF[3]	0.215	0.248	0.138	0.010
POF[4]	0.102	0.105	0.076	0.009
POF[5]	0.147	0.148	0.136	0.024
POF[6]	0.099	0.088	0.103	0.020
POF[7]	0.132	0.113	0.149	0.047
POF[8]	0.078	0.037	0.097	0.055
POF[9]	0.042	0.027	0.082	0.099
POF[10]	0.068	0.006	0.145	0.731

Source: Model database.

Note: The *Pesquisa de OrcamentosFamiliares* (POF) number indicates the household expenditure group.

Further information about income composition in Brazilian agriculture in 2001 can be seen in Table 8. One point regarding the information in this table should be stressed. It is well known that the PNAD heavily underestimates capital gains, which are normally much harder to record than wages. The figures for the share of "nonwages," which include capital gains, should therefore be regarded with care. The purpose of this table is more to illustrate an important feature of the Brazilian economy, which is the role of transfers. Transfers account for about 23.1 percent of the total income of self-employed workers in Brazilian agriculture, about 11 percent of employers' income, and much smaller shares for both permanent and temporary workers.

Table 8. Income composition in agriculture, according to the source of income shares, Brazil, 2001

Income source	Permanent	Temporary	Self Employ	Employer
Wage	0.951	0.935	0.732	0.831
Nonwage	0.020	0.018	0.037	0.059
Transfers	0.029	0.047	0.231	0.110
Total	1.000	1.000	1.000	1.000

Source: Model database.

5. THE SIMULATIONS

This section presents the results for the agricultural liberalization scenario, which assesses the likely impacts of a Doha Development Agenda agreement based on the Falconer draft on agriculture and the Stephenson draft on nonagricultural market access (NAMA). It emphasizes food and agriculture in developing countries (both middle-income and less-developed countries). The scenario simulated for Brazil is generated by running the MIRAGE model, which assumes a Doha agreement based on more recent 2008 draft texts, with implementation beginning in 2009 and results estimated for the year 2020. The main features of the simulated scenario for agriculture, at the global level, can be seen in Table 9. As for NAMA, the cuts are calculated through the use of the SWISS formula, with a 10% coefficient for developed countries, 25% for developing countries, and no cut for least developed countries. Applied domestic support levels are cut by 10%, while export subsidies are eliminated.

Table 9. Simulated global scenario: Agricultural market access

		Tariff reduction		
	Tiers %	**Not sensitive+special products**	**Sensitive+special products**	**Caps**
Developed countries	$0 \leq 20$	48%	24%	no
	$> 20 \leq 50$	55%	27.5%	
	$> 50 \leq 75$	62%	31%	
	> 75	65%	32.5%	
Developing countries	$0 \leq 30$	48%*(2/3)	48%*(1/3)	no
	$> 30 \leq 80$	55%*(2/3)	55%*(1/3)	
	$> 80 \leq 130$	62%*(2/3)	62%*(1/3)	
	> 130	65%*(2/3)	65%*(1/3)	
Least developed countries	No cut			
Developed countries	5% of sensitive tariff lines + 0% of special tariff lines			
Developing countries	7% of sensitive tariff lines + 8% of special tariff lines			

Model's Closure

On the supply side, national employment is fixed by occupation, with interregional wage differentials driving labor migration between states.[14] 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 agricultural land stock in each region (used only for agricultural activity) is fixed.[15] The mining sectors (mineral extraction, petrol and gas extraction, and nonmetallic minerals) have a fixed factor called "natural resources," which has a role in the model similar to that of agricultural land and is also fixed. 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.[16] A fixed [nominal trade balance/GDP] ratio enforces the

[14] For a particular occupation and state, intersectoral wage variation is fixed. For the microsimulation, the assumption is that jobs created (or lost) in a state are allotted to (or taken from) households in that state.

[15] The factor market closure causes the model to generate percent changes in prices for 10 labor types, capital, and land; the price changes vary across states. Percent changes in demand for each of the 12 factors also vary by sector and state. Each adult in the PNAD microdata is identified by stateand labor 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 states (and hence between households).

[16] That is, investment/capital ratios are fixed. With national capital stock, changes in aggregate investment are also limited but do arise from intersectoral variations in initial investment/capital ratios.

national budget balance, which is accommodated by changes in real consumption. The trade balance, then, drives the level of absorption. The national consumer price index (CPI) is the model's numeraire.

6. RESULTS

The CGE Model Results

Even though the situation has improved since the early 1990s, the Brazilian economy still has a limited exposure to external trade. The shares of exports and imports in total GDP were 13.8 and 14.7 percent, respectively, in the 2001 base year (those figures were 7.0 and 8.9 percent in 1996). Table 10 presents more information about the structure of Brazilian external trade and related parameters and production structure, while Table 11 shows the nature and size of the shocks applied to the model.

The shocks generated by a previous run of the MIRAGE model are applied to the CGE model, where the global trade liberalization scenario is implemented. The world price effects on the Brazilian economy are then transmitted to the Brazil CGE model through import prices changes and shifts in the demand schedules for the Brazilian exports.[17]

An inspection of Tables 10 and 11 gives an idea of the importance of these shocks as well as the importance of each commodity in Brazilian external trade. Brazilian exports are spread among many different commodities, with no specialized trend. Raw agricultural products, composed almost entirely of soybeans, have only a small share in total exports. Processed food and agricultural-based exports (including wood and furniture, rubber, paper, textiles, and apparel), however, account for a significant 30 percent share of total exports in the base year, highlighting the importance of agriculture in the Brazilian economy.

Imports as a share of each domestic product are concentrated in wheat, oil, machinery, electric materials and electronic equipment, and chemical products. In terms of total import shares, however, oil products (raw and refined), machinery, electric materials and electronic equipment, and chemical products are most important.

Table 10 also shows some relevant parameters and other production characteristics of the model. The Armington elasticities are borrowed from the MIRAGE model. The export demand elasticities (not shown in the table) are equal to the Global Trade Analysis Project's (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 10 is the same for every agricultural product. The value of land is not included in the value of capital here. If land were included, the value of the capital/labor ratio in agriculture would rise to 0.99.

The size and direction of the shocks applied to the Brazilian model can be seen in Table 11, which indicates changes in the percentages of import tariffs, import CIF prices, and implied shifts in the export demand curve generated by a previous run of the MIRAGE, which does not include the liberalization in Brazil. There is no liberalization of services in the simulated scenario.

[17] The shifts in the demand schedules for Brazilian exports are calculated using export price and quantity results (and export demand elasticities) from the MIRAGE model, using the method of Horridge and Zhai (2005).

Table 10. Brazilian external trade structure

Commodity	EXTERNAL TRADE					
	Armington elasticities (from Mirage model)	Share in total Brazilian exports	Exported share of total output	Imported share in local markets	Share in total imports	Capital/ labor ratio
Coffee	3.25	0.00	0.00	0.00	0.00	0.72
Sugarcane	2.70	0.00	0.00	0.00	0.00	0.72
Paddy rice	5.05	0.00	0.00	0.02	0.00	0.72
Wheat	4.45	0.00	0.00	0.72	0.01	0.72
Soybeans	2.45	0.03	0.38	0.03	0.00	0.72
Cotton	2.50	0.00	0.00	0.00	0.00	0.72
Corn	1.30	0.01	0.16	0.02	0.00	0.72
Livestock	1.50	0.00	0.00	0.00	0.00	0.72
NaturMilk	3.65	0.00	0.00	0.00	0.00	0.72
Poultry	1.30	0.00	0.00	0.01	0.00	0.72
OtherAgric	1.81	0.02	0.03	0.02	0.01	0.72
MineralExtr	0.90	0.04	0.56	0.07	0.01	0.92
PetrGasExtr	5.86	0.01	0.05	0.24	0.06	14.01
MinNonMet	2.90	0.01	0.07	0.04	0.01	1.62
IronProduc	2.95	0.04	0.16	0.05	0.01	7.18
MetalNonFerr	4.20	0.03	0.19	0.12	0.02	3.80
OtherMetal	3.75	0.02	0.07	0.08	0.02	0.26
MachTractor	4.30	0.03	0.10	0.22	0.08	1.93
EletricMat	4.05	0.02	0.14	0.29	0.05	0.68
EletronEquip	4.40	0.03	0.36	0.56	0.10	2.15
Automobiles	2.80	0.05	0.23	0.14	0.03	2.03
OthVeicSpare	4.30	0.09	0.41	0.25	0.07	0.75
WoodFurnit	3.40	0.03	0.21	0.03	0.00	0.53
PaperGraph	2.95	0.03	0.11	0.05	0.01	1.20
RubberInd	3.30	0.01	0.12	0.13	0.01	3.31
ChemicElem	3.30	0.01	0.10	0.18	0.03	6.84
PetrolRefin	2.10	0.05	0.07	0.13	0.10	21.68
VariousChem	3.30	0.01	0.06	0.17	0.04	1.22
PharmacPerf	3.30	0.01	0.05	0.25	0.04	1.65
Textiles	3.75	0.02	0.10	0.10	0.02	0.56
Apparel	3.70	0.00	0.02	0.02	0.00	0.39
ShoesInd	4.05	0.04	0.63	0.07	0.00	1.31
CoffeeInd	1.15	0.02	0.22	0.00	0.00	3.77
VegetProcess	2.21	0.03	0.14	0.04	0.01	0.95
Slaughter	3.96	0.04	0.16	0.01	0.00	1.36

Table 10. Continued

	EXTERNAL TRADE					
	Armington elasticities (from Mirage model)	**Share in total Brazilian exports**	**Exported share of total output**	**Imported share in local markets**	**Share in total imports**	**Capital/ Labor ratio**
Dairy	3.65	0.00	0.01	0.03	0.00	2.17
SugarInd	2.70	0.03	0.37	0.00	0.00	3.50
VegetOils	3.30	0.04	0.29	0.02	0.00	5.53
OthFood	1.63	0.02	0.08	0.05	0.01	0.88
VariousInd	3.75	0.01	0.12	0.23	0.02	1.89
PubUtilServ	2.80	0.00	0.00	0.03	0.01	1.77
CivilConst	1.90	0.00	0.00	0.00	0.00	4.09
Trade	1.90	0.01	0.03	0.04	0.01	0.16
Transport	1.90	0.06	0.14	0.10	0.04	0.04
Comunic	1.90	0.00	0.01	0.01	0.00	1.90
FinancInst	1.90	0.01	0.01	0.02	0.01	0.38
FamServic	1.90	0.03	0.04	0.07	0.05	0.10
EnterpServ	1.90	0.06	0.15	0.18	0.09	0.44
BuildRentals	1.90	0.00	0.00	0.00	0.00	46.46
PublAdm	1.90	0.01	0.01	0.01	0.02	0.00
NMercPriSer	1.90	0.00	0.00	0.00	0.00	0.00

Table 11. Shocks (% changes) to the CGE model

Commodity	**Import tariffs**	**Import CIF prices**	**Implied export price shifts[a]**
Coffee	-0.01	1.99	2.93
Sugarcane	0	1.86	-0.99
Paddy rice	0	1.76	-1.54
Wheat	0	1.47	2.06
Soybeans	0	2.60	8.99
Cotton	0	1.65	0.39
Corn	0	2.06	3.51
Livestock	-2.52	2.63	0.49
NaturMilk	0	2.16	0.62
Poultry	-3.68	2.56	0.95
OtherAgric	0	1.66	1.32
MineralExtr	-0.56	1.05	0.15
PetrGasExtr	0	0.80	0.43
MinNonMet	-8.24	1.28	2.24
IronProduc	-3.98	1.27	0.73
MetalNonFerr	-3.37	1.27	0.39

Table 11. Continued

Commodity	Import tariffs	Import CIF prices	Implied export price shifts[a]
OtherMetal	-15.72	1.31	1.76
MachTractor	-5.78	1.30	-0.10
EletricMat	-10.91	1.37	1.01
EletronEquip	-8.93	1.28	0.91
Automobiles	-45.20	1.24	3.90
OthVeicSpare	-5.78	1.30	-0.10
WoodFurnit	-15.90	1.37	0.71
PaperGraph	-6.20	1.31	0.90
RubberInd	-16.59	1.36	1.33
ChemicElem	-16.59	1.36	1.33
PetrolRefin	0	0.91	0.78
VariousChem	-16.59	1.36	1.33
PharmacPerf	-16.59	1.36	1.33
Plastics	-16.59	1.36	1.33
Textiles	-21.50	1.31	1.73
Apparel	-30.96	1.27	4.30
ShoesInd	-20.52	1.39	0.29
CoffeeInd	-0.18	1.59	19.24
VegetProcess	-0.78	1.56	1.89
Slaughter	0	2.38	9.03
Dairy	0	2.04	11.66
SugarInd	0	1.75	4.23
VegetOils	0	2.05	-0.24
OthFood	-0.79	1.55	1.90
VariousInd	-24.12	1.46	1.46
PubUtilServ	0	1.55	0.21
CivilConst	0	1.72	0.15
Trade	0	1.50	0.24
Transport	0	1.27	0.22
Comunic	0	1.74	0.27
FinancInst	0	1.51	0.30
FamServic	0	1.38	0.21
EnterpServ	0	1.68	0.25
BuildRentals	0	0	2.12
PublAdm	0	1.39	0.28
NMercPriSer	0	1.38	0.21

Notes: [a] The vertical shift in the export demand schedule is calculated from Linkage model results.

Next we present some macro results in order to establish a benchmark for the regional and poverty analysis (Table 12). 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.

Table 12. Percentage change in selected macroeconomic results

Macro	Percentage change
Real household consumption	0.05
Real investment	0.00
Real government expenditure	0.0
Export volume	0.64
Import volume	1.04
Real GDP	0.01
Aggregate employment	0.00
Average real wage	0.08
Aggregated capital stock	0.00
GDP Price Index	-0.01
Consumer Price Index	0.00
Export Price Index	0.24
Import Price Index	-0.21
Nominal GDP	0.00
Land price (national)	6.15

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. 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 land also shows a strong increase, reflecting the increase in production of activities using this factor (agriculture).

National changes in industrial output are shown in Table 13 agriculture and agricultural-related industries (most of the food industries) would expand, with the exception of the vegetable oils industry, which contracts as a consequence of the (negative) export shock. This is basically caused by a sharp fall in Brazil's export quantities in the MIRAGE model for this sector (–14.42 percent), even though accompanied by a 2.14 percent price increase. As for the manufacturing sectors, model results show a general fall in activity following trade liberalization. This suggests that regions specializing in manufacturing would fare worse.

Table 13. Activity level and employment variation by industry (% changes)

Industry	Activity level	Employment
Agriculture	1.87	1.80
MineralExtr	-1.23	-1.93
PetrGasExtr	-0.36	-0.36
MinNonMet	0.11	0.08
IronProduc	-1.49	-1.34
MetalNonFerr	-2.81	-2.67
OtherMetal	-1.05	-1.01
MachTractor	-1.60	-1.40
EletricMat	-0.90	-0.78
EletronEquip	-1.12	-0.92
Automobiles	2.50	2.74
OthVeicSpare	-4.41	-4.27
WoodFurnit	-0.90	-0.95
PaperGraph	-0.36	-0.25
RubberInd	-0.73	-0.52
ChemicElem	-0.88	-0.74
PetrolRefin	-0.16	0.18
VariousChem	0.30	0.39
PharmacPerf	-0.05	0.11
Plastics	-0.76	-0.69
Textiles	-0.07	-0.14
Apparel	0.11	0.09
ShoesInd	-6.55	-6.57
CoffeeInd	11.35	11.22
VegetProcess	0.50	0.42
Slaughter	4.98	4.87
Dairy	0.79	0.69
SugarInd	5.64	5.51
VegetOils	-5.50	-5.61
OthFood	0.32	0.25
VariousInd	-1.39	-1.58
PubUtilServ	-0.22	-0.18
CivilConst	-0.03	-0.10
Trade	0.14	0.13
Transport	-0.15	-0.15
Comunic	-0.05	0.14
FinancInst	-0.07	0.03
FamServic	-0.39	-0.42
EnterpServ	-0.40	-0.34
BuildRentals	-0.11	0.26
PublAdm	-0.03	-0.03
NMercPriSer	-0.19	-0.19

Table 14 shows selected regional results. In this table, states are grouped according to their regions (N, NE, SE, S, and CW). For each of the 10 labor types, total employment is fixed, so labor demand (and unemployment) will be redistributed among regions according to changes in regional industry output. Employment falls in São Paulo and Rio de Janeiro (the most populous and industrialized states) in the SE region, in Rio Grande do Sul, in the S region, and also in the states of Amazonas and Ceará. The latter two are relatively less important in economic terms, but poverty is relatively high there.

São Paulo and Rio de Janeiro are industrial states, possessing the bulk of Brazil's manufacturing. As seen before, manufacturing in general is contracting. The same effect drives the results for Amazonas, where a free exporting zone exists. As for the state of Rio Grande do Sul, the result is mainly driven by the fall in the activity level of the vegetable oils industry. And finally, the negative employment result in Ceara is caused by declines in the civil construction and trade sectors.

Table 144. Percentage changes for 27 states, Brazil, 2001

State	Region	Real GDP	Aggregate employment	Nominal GDP
Rondonia	N	0.86	0.44	1.48
Acre	N	0.73	0.36	1.39
Amazonas	N	-0.38	-0.31	-0.59
Roraima	N	0.34	0.16	0.55
Para	N	0.33	0.22	0.79
Amapa	N	0.27	0.11	0.81
Tocantins	N	0.74	0.52	1.33
Maranhao	NE	0.73	0.46	1.27
Piaui	NE	0.34	0.18	0.56
Ceara	NE	-0.31	-0.18	-0.45
RGNorte	NE	0.03	0.04	-0.04
Paraiba	NE	0.26	0.08	0.44
Pernambuco	NE	0.08	0.02	0.09
Alagoas	NE	0.70	0.35	1.06
Sergipe	NE	0.09	0.02	0.08
Bahia	NE	0.20	0.15	0.36
MinasG	SE	0.21	0.13	0.40
EspSanto	SE	0.28	0.16	0.48
RioJaneiro	SE	-0.26	-0.18	-0.52
SaoPaulo	SE	-0.14	-0.12	-0.35
Parana	S	0.49	0.28	0.91
StaCatari	S	0.20	0.19	0.38
RGSul	S	-0.27	-0.14	-0.33
MtGrSul	CW	1.25	0.82	2.38
MtGrosso	CW	1.31	0.87	2.58
Goias	CW	0.57	0.40	1.11
DF	CW	0.03	0.03	-0.08

It can be seen then that the trade liberalization scenario redistributes economic activity toward the poorer regions. However, this occurs because higher value-added sectors (manufacturing) shrink, and relatively lower value-added sectors (agriculture) grow. This issue is important in the context of the

simulation, since the movement is contrary to the goal pursued by the country during the 1970s import substitution period, when economic policy was directed toward promoting industrialization.

The changes in wages, by occupation, can be seen in Table 15. As it can be seen from the table, relative wages increase for the lowest wages as a consequence of the shocks, with the largest positive increase observed in the first occupation (OCC1). This is, of course, related to the structure of labor demand in agriculture and manufacturing, as discussed previously.

Table 155. Model results changes in wages, by occupation

Wage	Percent variation
OCC1	4.46
OCC2	1.47
OCC3	0.51
OCC4	0.10
OCC5	-0.26
OCC6	-0.52
OCC7	-0.79
OCC8	-0.92
OCC9	-0.90
OCC10	-0.93

Poverty and Income Distribution Results

The uneven distribution of the economic activity in the Brazilian territory generates spatially differentiated impacts of the trade shocks in the simulation. The outcome of these changes to income and income inequality measures as well as to income-group–specific consumer price indexes are discussed in this section. In Table 16, the lowest household income group is POF[1] and the highest is POF[10]. In the simulation, the GINI index falls by 0.33 percent.

Table 16. Average household income, Consumer Price Index, by household income group, and GINI index (% change)

Household Income Group	Average Income	Consumer Price Index
POF[1]	7.38	0.20
POF[2]	1.57	0.18
POF[3]	0.91	0.15
POF[4]	0.37	0.11
POF[5]	0.21	0.10
POF[6]	-0.09	0.08
POF[7]	-0.29	0.05
POF[8]	-0.47	0.01
POF[9]	-0.55	-0.02
POF[10]	-0.60	-0.10
GINI	-0.33	

The Consumer Price Index (CPI) column in each scenario gives the change in CPI for each household income group, since the consumption bundle is different for each class. Most of the effect on real income comes from the income generation side and not from a fall in prices. Actually, there is a strong increase in some food prices—meat, coffee, and sugar products—driven mainly by liberalization in the rest of the world. This is the opposite of what is likely to happen in net food-importing countries. As an important food exporter, the push in exports in Brazil raises prices due to increased marginal cost curves. The results here suggest that the CPI would actually go up more in the lowest income groups, which have a larger share of their income concentrated in food, but the income increase more than compensates for the increase in food prices.

An important point to note is that the highest positive changes in household income are concentrated among the lowest income households, decreasing monotonically as household income increases. Indeed, Table 17 shows that the reduction in the number of poor households is concentrated in the poorest groups. High positive figures in POF groups 7 and 8 are percentage changes over very low numbers, since there are very few poor households in these income groups.[18]

The headcount ratio index (FGT0 in Table 17) captures only the extension of poverty; it is insensitive to 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 within each household income group. As seen in Table 17, the FGT1 index decreases more than the headcount ratio in the poorest three household income groups. This suggests some improvement in income distribution but not enough to drive a large number of persons (or households) out of poverty. This results from the high value of those indexes in the base year, as noted before. [19].

Table 17. Percentage change in the number of poor households (FGT0) and in the poverty gap ratio (FGT1), by household income groups

Household income class	FGT0	FGT1
POF[1]	-0.69	-1.79
POF[2]	-0.49	-1.92
POF[3]	-0.39	-1.60
POF[4]	-1.97	-0.26
POF[5]	-1.53	2.38
POF[6]	2.73	11.69
POF[7]	11.99	64.20
POF[8]	104.74	448.34
POF[9]	0.00	0.00
POF[10]	0.00	0.00
Original values (base year)	-0.69	-1.80
Percentage change	-0.55	-1.53

Notes: FGT0 is the Foster-Greer-Thorbecke proportion of poor households index, or headcount ratio. FGT1 is the poverty gap ratio.

[18] Some middle-income households have many family members. With low per capita income, they fall below the poverty line.

[19] The very high numbers in POF[8] represent high percentage changes on tiny base year values, see Table 2.

Table 18 shows model results relating to the regional breakdown inside Brazil. These results summarize the outcome of the simulated scenario at regional level, as a net effect of the regional industries. They reflect, then, the pattern of regional specialization in production. In the table, the states of Amazonas, Rio de Janeiro, and São Paulo and the Federal District (DF) are the only ones where the number of households below the poverty line would increase. Rio de Janeiro and São Paulo are the most densely populated and industrialized states in Brazil. As noted before, the result is related to the high concentration of contracting (high value-added) industries in Rio de Janeiro and São Paulo, mainly automobiles, machinery and tractors, electric materials, electronic equipment, other vehicles and spare parts, and chemicals. The state of Amazonas has an electronic product industry that is important for the local economy, while service provision, which is intensive in the Federal District, faces a generalized fall in activity.

Table 18. Percentage change in number of poor households by state and total change in number

State	% change
Rondonia	-1.37
Acre	-0.65
Amazonas	0.79
Roraima	-0.16
Para	-0.38
Amapa	-0.08
Tocantins	-1.33
Maranhao	-0.77
Piaui	-0.49
Ceara	-0.06
RGNorte	-0.77
Paraiba	-1.20
Pernambuco	-0.47
Alagoas	-0.38
Sergipe	-0.58
Bahia	-0.89
MinasG	-1.12
EspSanto	-2.43
RioJaneiro	0.95
SaoPaulo	0.95
Parana	-1.94
StaCatari	-1.99
RGSul	-0.30
MtGrSul	-2.90
MtGrosso	-3.39
Goias	-1.62
DF	0.12
	Total number
Change in total number of poor households	-85,623
Change in total number of poor persons	-316,110

Source: Model results.

The results can also be used to examine a bit more carefully what happens within the agriculture sector, given its importance to poverty analysis in Brazil. As a net effect of the shocks, 260,963 new jobs would be created in agriculture. Agriculture's labor demand concentrates on the lowest skill workers. As a consequence, about 54 percent of those new jobs are located in the three lowest wage groups, following the labor demand structure.

This result is important. As observed by Balsadi (2005), during the period 1999–2003 alone, 930,000 persons left Brazilian agriculture, a period that the author considers favorable for agriculture in general. This movement toward the cities, although not as intense today as it was in the 1970s and 1980s, increases pressure on urban infrastructure in Brazil, with negative consequences, especially during periods of reduced economic growth. The results here, then, suggest that the trade liberalization scenario could help slow the pace of transfer of the population from rural to urban areas.

More results relating to agriculture can be seen in Table 19, which reports the percentage change in income of agents in agriculture, by occupational status and household income group. The income change by individual workers, when recomposed at the household level, makes the self-employed group in the poorest households (POF1) gain the most (among the non-employers), a 3.56 percent increase in their incomes. Notice that this gain is equivalent (in percentage change terms) to that for employers in the highest income groups for households, which reinforces the distributional impact of the simulated scenario.

Table 19. Income variation in agriculture, by occupational status (% change)

Income group	Permanent	Temporary	SelfEmploy	Employer
POF[1]	2.54	2.86	3.56	1.97
POF[2]	1.33	1.74	2.42	1.49
POF[3]	0.64	1.59	1.94	1.93
POF[4]	0.29	1.39	1.45	1.89
POF[5]	0.22	1.18	1.16	2.42
POF[6]	0.02	0.66	0.80	3.68
POF[7]	-0.17	0.65	0.43	3.52
POF[8]	-0.27	0.41	0.15	3.81
POF[9]	-0.16	-0.03	-0.10	3.67
POF[10]	0.13	0.46	-0.16	3.83

Source: Model results.

Brazilian agriculture is heterogeneous in its structure, and even commercial crops like soybeans and coffee can be produced on small properties, depending on the region where it is located. Location advantages allow small producers to coexist with larger producers in Brazil even when scale economies are present[20] (see, for example, Conte and Ferreira Filho 2007), since transportation and other costs produce an equalization of economic conditions. As a consequence, the size of the farm is not a good indicator of welfare, as seen in Table 20, which shows the income variation result (in percent), according to each household group and farm size.

There is no clear trend for gains, which tend to appear under different land ownership conditions. This contradicts the idea, sometimes raised in discussions about agricultural trade liberalization, that only large farmers would be gainers in the process. Even small producers in Brazil are strongly linked to markets, and there is no reason to believe that these producers would not benefit from the process, as the results here suggest.

[20] Notice, however, that the CGE model used is a perfect competition model.

Table 20. Income variation in agriculture, by household income group and farm size (% change)

Household income group	Up to 25	Up to 50	Up to 100	Up to 250	250 or more
POF[1]	2.70	2.62	1.62	0	1.64
POF[2]	1.32	3.18	2.47	1.74	1.57
POF[3]	1.87	2.14	2.11	3.51	3.95
POF[4]	1.68	1.58	2.97	3.76	-0.34
POF[5]	2.24	2.03	2.00	2.02	3.92
POF[6]	3.12	3.05	2.48	2.99	2.35
POF[7]	2.72	3.40	2.56	2.18	2.89
POF[8]	3.40	4.34	1.79	2.04	3.56
POF[9]	2.21	3.45	2.66	3.85	3.73
POF[10]	1.06	3.00	3.38	3.50	3.90

7. CONCLUDING REMARKS

The model results in this paper show that the simulated scenario has positive effects on poverty and income distribution in Brazil. Even though the decline in poverty is modest, the improvement in income distribution is greater, in percentage terms, than the poverty decline, indicating the importance of agricultural trade liberalization for poverty alleviation in Brazil.

The major role played by the agriculture sector in this analysis should also be stressed. Agriculture still accounts for a large share of employment for the poorest in Brazil. Despite the steady decline over time of agricultural employment as a share of total employment, we should not overlook the importance of the agricultural sector for poverty alleviation initiatives in the country. The results show that most of the net jobs created would be in agriculture and agriculture-related activities, where a large number of poor people are still concentrated. The policy simulated here, then, would help slow the transfer of people from the rural to the urban areas, reducing pressure on the urban infrastructure and the social costs associated with urbanization.

And, finally, the study finds no evidence that trade liberalization in agriculture would exclusively benefit large farmers in Brazil. Although results are mixed across regions, the study shows that income changes would benefit all agents in the agricultural sector, including temporary workers, permanent workers, the self-employed, and small farmers. The policy, then, should be regarded as an important complement to the current effort on poverty alleviation in Brazil. It is a mechanism that works through the market, in contrast to the present federal government minimum wage and transfers policies, which are now in effect in Brazil. As shown in Balsadi (2005), the share of workers that receive more than the minimum wage in Brazil is increasing, and in Center West and South regions in 2005, it reached more than 75 percent of total permanent workers. This is in accordance with Giambiagi and Franco (2007), who argue that the role of the minimum wage policy as an instrument for poverty alleviation is close to its limit in Brazil.

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APPENDIX: SUPPLEMENTARY TABLE

Table A.1. Sectors description in the model

Sector	Description
Agriculture	Agriculture
MineralExtr	Mineral Extraction
PetrGasExtr	Petroleum and Gas extraction
MinNonMet	Non Metallic Minerals
IronProduc	Iron Products
MetalNonFerr	Non Ferrous Metals
OtherMetal	Other Metals Products
MachTractor	Machines and Tractors
EletricMat	Electric Equipment
EletronEquip	Electronic Equipment
Automobiles	Automobiles
OthVeicSpare	Other Vehicles and Spare Parts
WoodFurnit	Wood and Furniture
PaperGraph	Paper and Graphic
RubberInd	Rubber Industry
ChemicElem	Chemical Elements
PetrolRefin	Refined Petrol
VariousChem	Various Chemicals
PharmacPerf	Pharmaceuticals and Perfumes
Plastics	Plastics
Textiles	Textiles
Apparel	Apparel
ShoesInd	Shoes Industry and Leather
CoffeeInd	Coffee Industry
VegetProcess	Vegetable Processing
Slaughter	Slaughter
Dairy	Dairy
SugarInd	Sugar Industry
VegetOils	Vegetable Oils
OthFood	Other Foods
VariousInd	Other Industries
PubUtilServ	Public Utilities Services
CivilConst	Civil Construction
Trade	Trade
Transport	Transport
Comunic	Communications
FinancInst	Financial Institutions
FamServic	Services to Families
EnterpServ	Services to Enterprises
BuildRentals	Building rentals
PublAdm	Public Administration
NMercPriSer	Non Mercantile Private Services

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