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Would Trade Liberalization Help the Poor of Brazil?

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Abstract

This paper addresses the potential effects of world agricultural trade liberalization on poverty and regional income distribution in Brazil, using an inter-regional applied general equilibrium (AGE) and a micro-simulation model of Brazil tailored for income distribution and poverty analysis by using a detailed representation of households. The model distinguishes 10 different labor types and has 270 different household expenditure patterns. Income can originate from 41 different production activities located in 27 different regions in the country. The AGE model communicates to a micro-simulation model that has around 112,000 Brazilian households and 264,000 adults. Poverty and income distribution indices are computed over the entire sample of households and persons, before and after the policy shocks. The simulated trade liberalization scenario causes agriculture to expand considerably and so, given the importance that agriculture still has for the poorest in Brazil, it has positive impacts on poverty in Brazil. The only states which show an increase in the number of poor households are Sao Paulo and Rio de Janeiro, where the bulk of the manufacturing activities in Brazil are concentrated. There is an even more positive impact on inequality. The higher fall in the poverty gap is shown to occur mainly on the poorest household groups, suggesting that the poorest among Brazil's poor would benefit more from global trade liberalization.

JEL codes: D30, D58, D63, F13, O53, Q18

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Would Trade Liberalization Help the Poor of Brazil?

Joaquim Bento and Mark Horridge

Brazil exhibits a high degree of income concentration, and that inequality has persisted throughout the dramatic economic and political changes of the past 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 addressed in this study is: how much would such trade reform-induced growth benefit the poor?

To answer that question, this chapter provides a quantitative *ex ante* assessment using a computable general equilibrium (CGE) 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. It builds on the authors' earlier analyses (e.g., Ferreira Filho and Horridge 2006) which link national CGE and micro-simulation models to analyze the income distribution effects of trade policy changes. Distinctive features of this most recent analysis are that the World Bank's Linkage model (van der Mensbrugghe 2005) provides the external terms of trade shock from rest-of-world trade liberalization, and the use of a full inter-regional (bottom-up) CGE model of Brazil's 27 states based on the 2001 input-output table.[1] We also bring to bear new farm price distortions estimates for other developing countries,[2] in order to assess the impact of rest-of-world trade reform on poverty and inequality in Brazil.

The chapter begins with some background on previous similar analyses and data on poverty and income distribution in Brazil. The methodology to be used here is then described, along with a discussion of the relevant literature on the many different approaches. The model itself is presented next, along with a discussion of its database, followed by a discussion of results. The chapter finishes with some concluding remarks.

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[1] This approach follows closely that by Ferreira Filho et al (2007). Previous studies used a simpler top-down or inter-regional model with regional differentiation of quantity (but not price) changes and the 1996 input-output table.

[2] Estimates of agricultural protection/assistance for Brazil, based on Lopez et al. (2008), are incorporated in the World Bank's global agricultural distortions database (Anderson and Valenzuela 2008). Those estimates cover five decades, but the representative values for developing country agriculture as of 2004 that are used in the global CGE modeling for this study are summarized in Valenzuela and Anderson (2008).

Evolution of poverty and income distribution in Brazil

Although Brazil has many poor people, it is not (on average) a very poor country: as many as 77 percent of the world's people, and 64 percent of nations, have average incomes less than Brazil's. But, due to a particularly uneven income distribution, about 30 percent of Brazilians are poor, a figure which would be just 8 percent if incomes in Brazil were distributed as evenly as in other countries with similar per capita incomes (Barros, Henriques and Mendonça 2001). The same authors show that in 1999 one-third of the Brazilian population lived in households with income below the poverty line (about 53 million people, down from 40 percent in 1977), and 14 percent lived in extreme poverty. Whether measured as a percentage of the population or in terms of a poverty gap, Brazil's poverty stabilized between the second half of the 1980s and 2001 at a lower level than previously, before the situation started to change again, as will be seen below.

Barros and Mendonça (1997) analyze the impact on poverty of the relationship between economic growth and reductions in inequality in Brazil. They conclude that an improvement in the distribution of income would be more effective for poverty reduction than economic growth that 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, if the level of inequality in Brazil became closer to what can be observed in a typical Latin American country.

Brazilian poverty also has an important regional dimension. According to a study by Rocha (1998) for the 1981-95 period, the richer Southeast region of the country, which accounted for 44 percent of total population in 1995, had only 33 percent of the poor. These figures were 15.4 percent for the Southern region (8.2 percent of poor), and 6.8 percent for the Center-West region (5.2 percent of poor). For the poorer regions, by contrast, 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 percent (44 percent of poor) for the Northeast region which is the poorest region in the country.

The behavior of wages and the allocation of labor throughout the trade liberalization period in Brazil (1980-99) is analyzed by Green, Dickerson and Arbache (2001). They point out that wage inequality remained fairly constant in the 1980s and 1990s, with a small peak in the mid-1980s. That is, trade liberalization had little egalitarian consequence for Brazil in that period, but the authors note the low trade exposure of the Brazilian economy (around 13 percent in 1997) as well as the low 8 percent share of workers that had completed college studies.

The pattern of poverty in Brazil started to change from 2001. Barros et al. (2007a) show that while there was a 0.9 percent annual increase in national income during 2001-05, the income of the richest decreased: the annual increase of the 10 percent and 20 percent richest households' income was -0.3 percent and -0.1 percent, respectively, while the poorest households' income grew at 8 percent a year. There was thus a significant fall in the Gini index fell, of 4.6 percent, and a corresponding fall in poverty (by 4.5 percent). The latter was due mainly to the fall in inequality and not to the income increase. This was contrary to what has been historically observed in Brazil.

This unusual pattern of poverty reduction has attracted the attention of many experts, 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 percent of the fall during 2002-04 in the GINI index nationally (87 percent in the Northeast region),[3] and 86 percent of the poverty reduction, were associated with the share of household income due to transfers of the Bolsa Familia, the main Brazilian federal government income transfer program. That is, the recent improvement in poverty in Brazil is related to transfer programs, and so can be regarded as a short-run initiative and not necessarily permanent. This highlights the importance of assessing, as in this chapter, the role that could be played by market effects such as from trade reform as a source of permanent gain in poverty alleviation.

Methodology and data

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-

[3] Barros et al (2007b) found an even larger effect. According to these authors the federal government transfers were responsible for about 50 percent of the observed fall in inequality in Brazil in the 2001-2005 period.

group income distribution changes. Some more-recent CGE models recognize several household types, often distinguishing them by income level. For example, Gurgel et al. (2003) distinguish 20 household types, using a GTAP-derived multi-country model with additional Brazilian detail in which 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.

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 the distribution of real income are computed by comparing the unit record data pre- and post- updating. Savard (2003) points out that in this approach the causality usually runs from the CGE model to the micro-simulation model, with no feedback between them. The methodology used in the present study addresses this difficulty by constraining certain aggregate results (e.g., aggregate household use of each good) from the micro-simulation model to equal corresponding variables in the CGE model.[4] The main advantages of the two-model approach (CGE and MS) are that it avoids having to scale the microeconomic data to match the aggregated macro data, it can accommodate more households in the MS model, and the MS model can 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's economy. It is based on the TERM model of Australia (Horridge, Madden and Wittwer 2005). [5] It consists 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 constant elasticity of substitution (CES) composite good. Household consumption of these domestic/imported composites is modeled through the Linear Expenditure System, while intermediate demand is Leontief (fixed input-output

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[4] Another approach, following Savard (2003), is to iterate, whereby 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.

[5] 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.

coefficients). 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, and the agricultural industry (“Agriculture”) distributes its output between 11 agricultural commodities according to a constant elasticity of transformation (CET) constraint. Export volumes are determined by constant-elasticity[6] foreign demand schedules.

The regional CGE models are linked by trade in goods underpinned by large arrays of inter-regional trade that record, for each commodity, the source region and the destination region, the values of Brazilian and foreign goods transported, and the associated transport or trade margins.[7] Thus consumers of, say, vegetables in São Paulo substitute between vegetables produced in the 27 states according to their relative prices, under a CES demand system.[8]

A variety of labor market closures are possible. For the simulations reported here, employment of each of the 10 occupational groups is 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 nonlinear equations. It is solved with GEMPACK software. The CGE model is calibrated with data from two main sources: the 2001 Brazilian Input-Output Matrix (IBGE 2001a),[9] and some shares derived from the Brazilian Agricultural Census (IBGE 1996a) and the Pesquisa Agrícola Municipal (IBGE 2001b).

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 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 expenditure survey (POF) 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

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[6] For the simulations reported here, we set the export demand elasticities to values derived from the Linkage model, so as to increase consistency between results for the global and Brazil models.

[7] The dimensions of this margins matrix are 52*2*2*27*27.

[8] 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.

[9] The 2001 Brazilian Input-Output database used in this study was generated by Ferreira Filho, 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 for 1996.

the expenditure side of the micro-simulation dataset is incorporated within the main CGE model.

There are two main sources of information for the household micro-simulation model: the PNAD or National Household Survey (IBGE 2001a), and the POF or Household Expenditure Survey (IBGE 1996b). The PNAD contains information about households and persons, and shows a total of 331,263 records. The main information extracted from PNAD were wages 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 is an expenditure survey that covers 11 major metropolitan regions in Brazil (that is, only urban areas). The main information drawn from this survey, which provides the consumption bundle structure in 1996 for 16,014 households, 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.

Procedure for running the models

As already mentioned, the model consists of two main parts: a computable general equilibrium model (CGE) and a household micro-simulation model (MS). The models are run sequentially, with consistency between the two models assured by constraining the MS 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 very closely predicts MS aggregate behavior that is also included in the CGE model (such as household demands or labor supplies). 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 on groups not identified by the CGE model, such as by ethnic type, educational level or family status. To conform with the global Linkage model structure, labor supplies are fixed. Furthermore, each household in the micro data set had one of the 270 expenditure patterns identified in the main CGE model. There is thus very little scope for the MS to disagree with the CGE model.

The simulation starts with a set of trade shocks generated by simulations from the World Bank’s Linkage model involving the abolition of distortions to agricultural or all merchandise trade outside Brazil. These shocks consist of changes in import prices and in export demands. The export demand changes are implemented in the Brazil CGE model via vertical shifts in the export demand curves facing Brazil. When these trade shocks are applied, results are generated for 52 commodities, 42 industries, 10 households and 10 labor occupations, all of which vary across the 27 regions.

Next, the results from the Brazil CGE model are used to update the MS model. At first, this involves updating wages and hours worked for the 263,938 workers in the sample. These changes have a regional as well as sectoral dimension (27 regions, 42 industries). The model then relocates jobs according to changes in labor demand.[10] This is done by changing the PNAD weight of each worker in order to mimic the change in employment (see Appendix for details). In this approach, 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 in the CGE model, it may have considerable impact on the variance of income within a group.

One final point about the procedure is that, 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 households. 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 it is possible to recompose changes in the household income from changes in individual wages. This is a very important aspect of the model, since it is likely that family income variations are cushioned 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. National employment of each skill type is fixed, but shifting industry outputs redistribute the jobs between households.

The base year picture

[10] This “quantum method” is described in more detail in Ferreira Filho and Horridge (2005), as well as in the annex to the present chapter.

In this section the above description of poverty and income inequality in Brazil is extended. The base year for the analysis is 2001, for which aggregate indicators of poverty and income inequality are summarized in table 1. The rows correspond to household income classes, grouped according to the POF definitions in footnote a of the table, such that POF[1] is the lowest income class and POF[10] the highest. The first 5 income classes, while accounting for 53 percent of total population in Brazil, get only 17 percent of total income. The highest income class, by contrast, accounts for 11 percent of population and 46 percent of total income. The Gini index associated with the income distribution in Brazil in 2001, calculated using an equivalent household basis,[11] is 0.58. This makes Brazil's income distribution among the most unequal in the world.

The unemployment rate is also 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. The unemployment rate is 33 percent among the lowest income group (persons above 15 years), and just 4 percent among the richest (column 4 of table 1). The percentage of white people also increases considerably with household income, while the percentage of children decreases markedly (columns 5and 6). 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 average household income.[12] According to that criterion, 31 percent of Brazilian households in 2001 were poor.[13] This comprises 96 percent, 77 percent and 54 percent, respectively, of households in the first three income groups (column 9 of table 1),[14] or 35 million out of 112 million households in 2001.

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[11] 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. Because poverty is defined here on an equivalent basis, a few (very large) families in middle incomes groups fall below the poverty line.

[12] This poverty line is equivalent to US$48 in 2001.

[13] 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.

[14] 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 for the two highest income classes.

Table 1 also shows how much each POF group contributes to two indicators of poverty stressed by Foster, Greer and Thorbecke (1984). One is the group contributions to the share of all households below the poverty line: the two lowest income classes account for about half of the nation's 31 percent of households below the poverty line (column 9). The second indicator is the poverty gap, which is the share by which a group's average household income falls below the poverty line. For the first income class, that share is 73 percent (column 10), which means very large income increases for the poor are needed to significantly change the number in poverty.

Brazil's poverty and inequality picture also has an important regional dimension. Economic activity, particularly manufacturing, is located mainly in the South-East region, while agriculture is more dispersed among regions outside the two big city-states. The map in Figure 1 shows where regions are located, and shades them according to proportions of households in poverty. The states in the North (N) region account for 8 percent of total population, compared to 24 percent for the North-East (NE), 45 percent in the South-East (SE), 16 percent for South (S), and 7 percent for the Center-West (CW). In the SE region the state of São Paulo alone accounts for 23 percent of total Brazilian population (table 2).

Column 3 in table 2 shows the proportion of households in each region that are below the poverty line. 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 the poorest. If, however, regional population is taken into account, column 4 shows that the populous regions of Ceará, Pernambuco, Bahia, Minas Gerais and São Paulo contribute most to the Foster-Greer-Thorbecke poverty gap index.[15] The last column in table 2 shows the proportion by which a region's average household income falls below the poverty line (the regional poverty gap). The states in the NE regions plus the states of Tocantins and Para show the highest poverty gaps, while two states in the South (Santa Catarina and Rio Grande do Sul) show the lowest poverty gaps in Brazil, followed closely by São Paulo.[16]

Information about the labor structure of the economy can be seen in table 3. In this table the sectoral wage bill is split into the model's ten occupational groups. The occupational

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

[16] While Amapa state (in the North) shows a poverty gap in line with the richer states of the S-SE, this 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.

groups are defined in terms of a unit wage ranking. More (less) skilled workers are those in the highest (lowest) income classes. Agriculture is the activity most dependent on unskilled labor, who absorb 41 percent of that sector's labor bill, while Petroleum and Gas Extraction, and Petroleum Refining, are the most intensive users of skilled labor, with the 10th labor class accounting for more than 40 percent of wage payments in those activities (with Financial Institutions coming next, at 35 percent). 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 wage class 1. The Trade sector is the second largest employer of this type of labor. As for the higher-wage classes, the Financial Institutions and Public Administration sectors hire the largest numbers of such workers. As a general feature, wage earnings of the higher wage occupations are concentrated in the higher income households, and vice-versa. Most of the wages earned by workers in wage class 1 accrue to the three poorest households groups, while all the workers in the highest wage class are located in households from the 8th wage class and above. That is, household income classes are highly positively correlated with occupational wage earning classes.

The model simulations and results

This section presents results for a liberalization scenario involving the rest of the world removing all distortions to merchandise trade, in addition to Brazil. In the case of agricultural and lightly processed ag,[17] that reform involves the removal of all trade (import and export) taxes and subsidies, removal of all output taxes and subsidies, and removal of any farm input subsidies. For other non-agricultural goods, it involves just removal of all import tariffs and any export taxes. The results will be analyzed with the aid of a decomposition algorithm presented by Harrison et al (2000) which allows the presentation of both the total shocks results and it's decomposition according to the correspondent partial shocks: liberalization of farm products in the Rest or World (ROW ag), liberalization of non-

[17] Highly processed ag, beverages and tobacco (sectors 25 and 26 in the database of the Global Trade Analysis Project, GTAP), are included as part of manufacturing rather than agriculture. In the Brazil model's classification, these sectors correspond to CoffeeInd, VegetProcess and OthAg.

agricultural goods in the Rest of the World (ROW nonagd), liberalization in of farm products in Brazil only (Brazil ag), and liberalization in non-farm goods in Brazil only (Brazil nonag).

Model closure

The closure adopted for the national CGE model of Brazil's economy aims to mimic that of the World Bank's Linkage model that generated the foreign price and export demand shock. On the supply side, national employment by occupation is fixed,[18] with inter-regional real wage differentials driving labor migration between regions.[19] 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 agricultural and mining sectors) is fixed.[20] In the mining sectors (mineral extraction and petrol and gas extraction), however, this stock is treated as a "natural resources stock" and does not affect 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.[21] A fixed (nominal trade balance/GDP) ratio enforces the national budget balance, which is accommodated by changes in real consumption. The trade balance drives the level of absorption. The national consumer price index (CPI) is the model's numeraire. Finally, a tax replacement mechanism is in force, allowing the direct tax rate to adjust 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.

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[18] 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 labor constraints, yielded results similar to those reported here.

[19] 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.

[20] 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 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 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 regions (and hence between households).

[21] That is, investment/capital ratios are fixed. With national capital stock fixed, changes in aggregate investment are also limited but do arise from inter-sectoral variations in initial investment/capital ratios, even though the model is static.

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 (up from 7.0 and 8.9 percent, respectively, in 1996). The significance and structure of Brazilian external trade are summarized in table 4. The border price and export demand shocks applied to the national CGE model, shown in table 5, were generated by a previous run of the World Bank's global Linkage model (see Anderson, Valenzuela and van der Menbrugghe 2010). The border price effects for the Brazilian economy were transmitted to the Brazil CGE model through import prices changes and shifts in the demand schedules for the Brazilian exports.[22]

An inspection of tables 4 and 5 give an idea of the importance of these shocks combined with the importance of each commodity in Brazilian external trade. Brazil's exports are spread across many different commodities, with no strong specialization. Primary agricultural products have a very small share (mostly soybeans) in total exports. Processed ag 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 that broader sense in the Brazilian economy. Imports as a share of each domestic production are concentrated in wheat, petroleum, machinery, electric materials and electronic equipment, and chemical products. In terms of total import shares, the highest ranking are petroleum products (raw and refined), machinery, electric materials and electronic equipment, and chemical products.

The Agriculture sector is modeled as a multi-production sector, producing 11 commodities. Thus the value-based capital to labor ratio in table 4 is the same for every agricultural product. The value of land is not included in the value of capital but, if it was, the value of the capital/labor ratio in agriculture would rise to 1.11.[23]

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[22] 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). The Armington elasticities, reported in table 5, 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.

[23] The primary factor shares in agriculture are: land (0.19), labor (0.47) and capital (0.34). The labor bill in agriculture has been adjusted to take into account self employment wage income.

As for domestic production taxes, Agriculture (primary agriculture and livestock production) is the only sector with a negative (-0.7 percent or -0.007 points in levels) production tax in the database. To eliminate this tax the scenario includes a 0.007 points increase in that tax rate. In the lightly processed sectors there are production subsidies, and the shocks for them are Slaughter (-0.046), Dairy (-0.047), Sugar Industry (-0.048) and Vegetable Oils (-0.046).

National macroeconomic effects of this global liberalization shock are shown in table 6. Because the closure fixes total supply of all primary factors (land, the 10 categories of labor, and capital), GDP shows only a slight increase (0.1 percent). The real exchange rate rises (a revaluation) as a result of the shocks, with corresponding gains in the external terms of trade. The table also shows the subtotals associated to each partial shock. As it can be seen, liberalization of agricultural product markets in the Rest of the World generates the largest increase in Brazil's real GDP, as well as its real household consumption.

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 by 0.7 percent. With capital stocks and labor fixed in total, the expanding industries would attract capital and labor from the contracting ones, driving up real wages by 1.3 percent on average: the increase is 21 percent for the lowest wage class, is less for medium skills, and is negative at around -3 percent for higher skills. In those industries with falling capital/labor ratios the marginal productivity of capital increases, and hence so do capital returns. The real price of agricultural land also shows a 28 percent increase nationally, reflecting the increase in land demand in every state as a consequence of the increase in production of activities using this factor (Agriculture). Again, the bulk of this effect is generated by liberalization of agricultural markets in the rest of the world.

The total increase in exports volume (5.3 percent) is caused mainly by liberalization in non-agricultural markets in Brazil. This is caused by the fixity of the trade balance as a share of GDP in the closure. As seen in table 5, the trade shocks in the import side imply liberalization on imported manufactured goods, where the bulk of protection concentrates in Brazil. Since GDP does not change much, the increase in imports volumes (7.9 percent) must be matched by an increase in exports volumes (5.3 percent), which is facilitated by an exchange rate devaluation (-0.61).

National changes in industry output are shown in table 7. Agriculture and agricultural related industries expand, and there is a general fall in Brazilian manufacturing output following the trade liberalization. This suggests that regions specializing in manufacturing would fare worse, as indeed is the case (see table 8, where states are grouped according to their geographic zones inside Brazil). For each of the 10 labor types, total employment is fixed, so labor demand is redistributed among regions according to changes in regional industry output. As can be seen in table 8, employment falls in São Paulo and Rio de Janeiro in the Southeast region (the most populous and most industrialized states), and also in Amazonas and Rio Grande do Norte where there is a free exporting zone. Thus trade liberalization would redistribute economic activity towards poorer regions of Brazil, a result mainly driven by liberalization in agricultural markets in the Rest of the World.

Poverty and income distribution results

Given the differentiation of results among regions and industries, there are marked changes in income inequality and poverty as a result of the trade liberalization. Income-group-specific consumer price index changes are presented in table 9, and the GINI (inequality) index falls by a non-negligible 1.7 percent as a result of the re-allocation effects that change wages and the labor demand structure in expanding and contracting sectors.

The literature on poverty recognizes the importance of a change in inequality for growth. 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". According to those authors' estimates, from a poverty point of view the recent 4.6 percent fall in inequality observed in Brazil (2001-2005) is equivalent to a balanced growth rate of 11 percent (with no change in inequality), leading to the conclusion that a 1 percent fall in inequality is equivalent to an increase in income of 2.4 percent. Said differently, if the poor had to choose, they would be indifferent between a 1 percent fall in the GINI index or a 2.4 percent balanced increase in per capita income in Brazil. The simulation result of a 1.7 percent fall in the GINI index of inequality, then, would be equivalent, in terms of poverty reduction, of a 4.1 percent GDP increase above trend between the old and the new static equilibrium.

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 agricultural prices such as meats, driven mainly by 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 [a unilateral liberalization] would help reduce inequality in Brazil by reducing 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 income increases, as can be seen in table 10. Again, the strong positive real income effect for the poorest households is caused mainly by liberalization in agricultural markets in the Rest of the World.

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 9, 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 (as shown above in table 1) there are very few poor households in these income classes.[24]

The headcount ratio index (fourth column in table 9) captures only the extension of poverty, not its intensity. The change in the intensity of poverty can be seen in the fifth column, where the change in the poverty gap is shown: a fall in that index means a reduction in the severity of poverty inside each household income class. That index decreases more than the headcount ratio in the poorest three household income groups, thus reducing income inequality – but not enough to drive a large number of persons (or households) out of poverty, because of the high value of those indices in the base year.

Finally, the regional breakdown in poverty changes inside Brazil is reported in table 11. Only in the large, industrialized states of São Paulo and Rio de Janeiro, and in Amazonas (where there is a free-trade processing zone specialized in electronic products) would there be an increase in the number of households below the poverty line. This result is related to the high concentration in São Paulo and Rio de Janeiro of manufacturing industries, mainly automobiles, machinery and tractors, electric materials, electronic equipment, other vehicles and spare parts, and chemicals. The poverty gap increases only in Rio de Janeiro and not in São Paulo or Amazonas. This is because the agriculture-related (agriculture and lightly processed food) share of GDP is larger in São Paulo and Amazonas (see column 3 of Table 2). Higher wages and employment in agriculture reduce the poverty gap in these states, 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.

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

Conclusions

In conclusion, the simulated global trade liberalization scenario has positive impacts on poverty in Brazil, a result mainly driven by liberalization in the Rest of the World's agricultural markets. Even though the country is not very oriented towards external trade, the strong border 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 poorest and the agricultural sector is of disproportionate importance to the poorest workers.

For regions, this implies that in Brazil's manufacturing states, Sao Paulo and Rio de Janeiro (and Amazonas, but on a much smaller scale), the number of poor households increases. This happens because protection of import-competing manufacturing is reduced by own-country liberalization, and agriculture expands (because of rest-of-world reform) while manufacturing contracts. This is an important point. Brazil, like most of the other countries in Latin America, pursued import substitution policies in the past which benefited the manufacturing sector. The model results show that the trade liberalization scenario would reverse that somewhat, benefiting agricultural at the expense of industrial sectors.

Another important point arising from this analysis is the fall in inequality, which is even more dramatic than the fall in the number in poverty. This inequality improvement would be equivalent, in terms of poverty reduction, to a significant boost in GDP per capita. Furthermore, the biggest fall in the poverty gap is among the poorest household groups, suggesting that the poorest among Brazil's poor would tend to benefit most from global trade liberalization. In fact this result holds for every state in Brazil except Rio de Janeiro.

This chapter has avoided a rural versus urban split, due to the difficulties of this classification for Brazil. 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.[25] Approaching poverty through this household prism, and tracking the

[25] 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).

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). The more spending (and welfare) is a household phenomena, the more appropriate is the method used here.

Giambiagi and Franco (2007) note that one of the strategies used by the federal government in Brazil to fight poverty, namely increases in the minimum wage, seems to be close to its limit in terms of efficacy, especially in the poorest, Northeast, region. This region would be one of the most to benefit from global trade liberalization. Thus, a global freeing of trade would provide an alternative channel for helping Brazil's poor.

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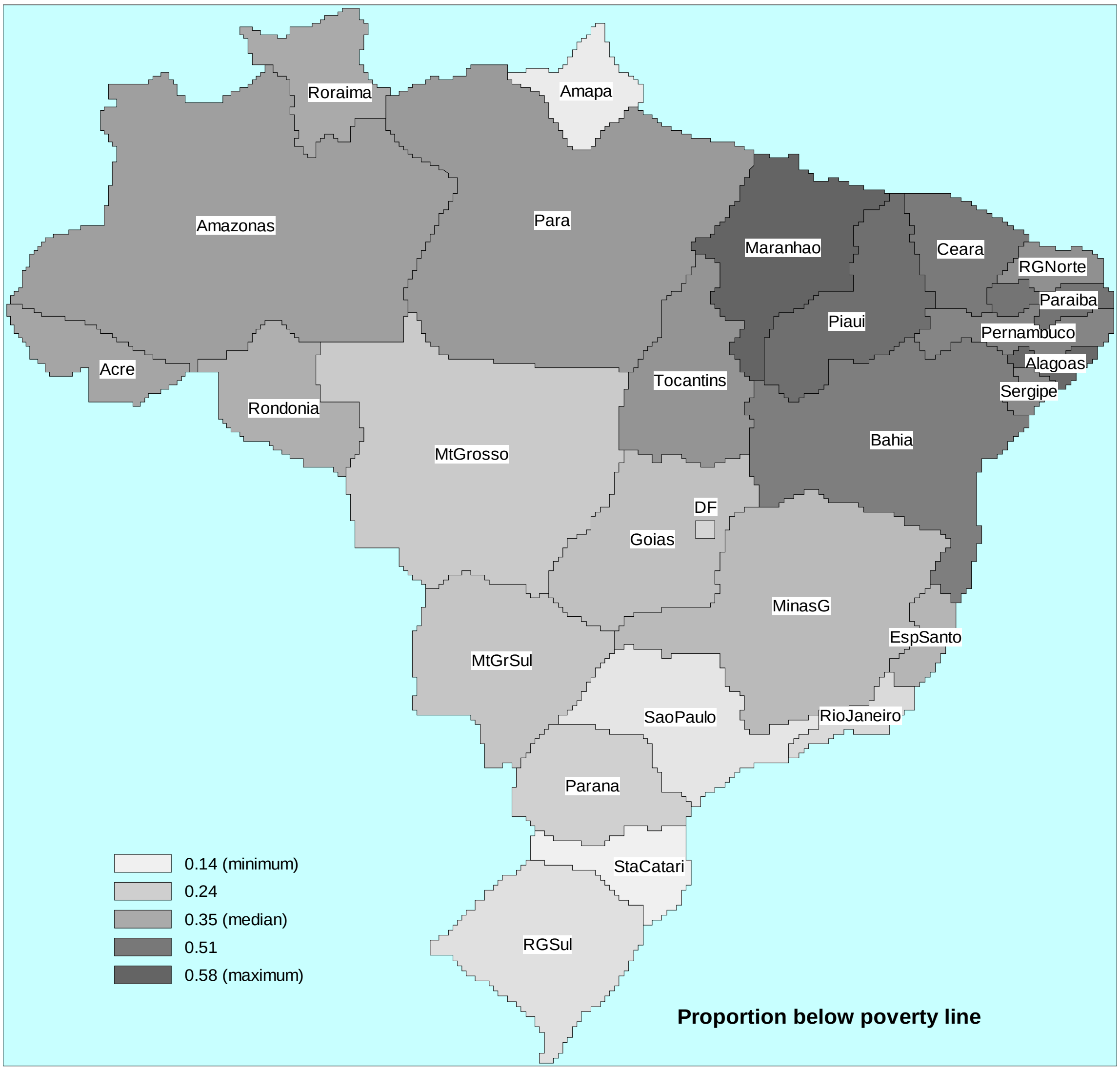
Figure 1: Brazil states shaded according to proportion in poverty. 2001.



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

Table 1: Poverty indicators, by poverty group, Brazil, 2001

(percent)

POF group[a]	Share of national population	Share of national income	Average household income (relative to that of POF[5])	Unemploy-ment rate	Whites' share of national population	Share of group's population under 15	Share of group's households below poverty line[b]	Group's contribution to share of h'holds below poverty line[b]	Poverty gap[c]	Group's contribution to national poverty gap[c]
POF[1]	10.7	0.9	0.1	32.6	35.2	46.2	96.2	11.22	73.3	8.56
POF[2]	8.0	1.8	0.4	17.3	38.3	37.2	76.6	7.16	30.5	2.85
POF[3]	16.0	5.2	0.6	10.4	42.0	35.1	53.6	8.77	15.0	2.45
POF[4]	7.3	3.1	0.8	8.8	45.1	32.5	28.4	2.02	5.4	0.38
POF[5]	11.0	5.8	1.0	7.5	49.2	28.7	11.4	1.22	1.9	0.20
POF[6]	7.9	5.1	1.2	7.4	53.4	26.4	3.9	0.29	0.5	0.04
POF[7]	12.9	11.1	1.7	6.8	60.3	24.5	0.8	0.10	0.1	0.01
POF[8]	7.5	8.7	2.3	6.1	66.3	21.5	0.1	0.01	0.0	0.00
POF[9]	7.7	12.7	3.1	5.9	71.2	20.5	0.0	0.00	0.0	0.00
POF[10]	10.9	45.7	7.9	4.2	81.6	17.7	0.0	0.00	0.0	0.00

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

[b] The national average share of households below the poverty line is 30. 8 percent (the sum of column 9).

[c] The percentage by which the group's average household income falls below the poverty line (national average is 14.6 percent, which is the sum of column 10).

Source: IBGE (2001a).

Table 2: Regional poverty and income inequality, Brazil, 2001

Regions	Macro-regions*	Region share of national population (1)	Region share of national agric-related GDP (2)	Share agric-related in regional GDP (3)	Share of poor households in regional population (4)	Regional contribution to national Poverty Gap[a] (5)	Regional average Poverty Gap[a] (6)
1 Rondonia	N	0.005	0.010	0.29	0.338	0.001	0.147
2 Acre	N	0.002	0.004	0.30	0.356	0.000	0.176
3 Amazonas	N	0.011	0.003	0.06	0.396	0.002	0.196
4 Roraima	N	0.001	0.001	0.16	0.347	0.000	0.152
5 Para	N	0.023	0.031	0.25	0.425	0.005	0.194
6 Amapa	N	0.003	0.002	0.13	0.151	0.000	0.069
7 Tocantins	N	0.006	0.007	0.26	0.429	0.001	0.180
8 Maranhao	NE	0.029	0.014	0.23	0.579	0.008	0.288
9 Piaui	NE	0.015	0.005	0.15	0.564	0.005	0.304
10 Ceara	NE	0.042	0.010	0.07	0.540	0.011	0.267
11 RGNorte	NE	0.016	0.006	0.07	0.471	0.004	0.218
12 Paraiba	NE	0.019	0.009	0.14	0.550	0.005	0.257
13 Pernambuco	NE	0.045	0.016	0.09	0.512	0.011	0.248
14 Alagoas	NE	0.015	0.012	0.24	0.577	0.004	0.289
15 Sergipe	NE	0.010	0.002	0.05	0.503	0.002	0.239
16 Bahia	NE	0.073	0.050	0.14	0.520	0.019	0.256
17 MinasG	SE	0.108	0.141	0.18	0.301	0.014	0.133
18 EspSanto	SE	0.019	0.025	0.17	0.324	0.003	0.144
19 RioJaneiro	SE	0.095	0.019	0.01	0.202	0.009	0.095
20 SaoPaulo	SE	0.229	0.219	0.06	0.166	0.019	0.083
21 Parana	S	0.059	0.112	0.19	0.237	0.006	0.100
22 StaCatari	S	0.034	0.076	0.18	0.136	0.002	0.055
23 RGSul	S	0.067	0.084	0.12	0.179	0.005	0.073
24 MtGrSul	CW	0.013	0.034	0.41	0.289	0.002	0.120
25 MtGrosso	CW	0.015	0.053	0.46	0.251	0.002	0.106
26 Goias	CW	0.031	0.046	0.23	0.300	0.004	0.126
27 DF	CW	0.013	0.006	0.02	0.219	0.001	0.106
Total	Brazil	1.000	1.00	0.10	0.308	0.145	0.145

[a] Macro-Regions are N = North; NE = North-East; SE = South-East; S = South; CW = Center-West.

[b] The proportion by which the group's average household income falls below the poverty line.

Source: IBGE (2001a).

Table 3: Share of occupations in each activity's labor bill, by wage class, Brazil, 2001 (percent)

	OCCUPATIONS (WAGE CLASS)										
Sectors	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
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
OthAg	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 (2001a).

Table 4: External trade structure, Brazil, 2001

(percent)

	Sectoral share of total exports	Share of total sectoral output exported	Share of local market supplied by imports	Sectoral share of total imports	Capital/ labor ratio
Coffee	0	0	0	0	0.72
SugarCane	0	0	0	0	0.72
PaddyRice	0	0	2	0	0.72
Wheat	0	0	72	1	0.72
Soybean	3	38	3	0	0.72
Cotton	0	0	0	0	0.72
Corn	1	16	2	0	0.72
Livestock	0	0	0	0	0.72
NaturMilk	0	0	0	0	0.72
Poultry	0	0	1	0	0.72
OtherAgric	2	3	2	1	0.72
MineralExtr	4	56	7	1	0.25
PetrGasExtr	1	5	24	6	6.59
MinNonMet	1	7	4	1	0.71
IronProduc	4	16	5	1	7.18
MetalNonFerr	3	19	12	2	3.80
OtherMetal	2	7	8	2	0.26
MachTractor	3	10	22	8	1.93
EletricMat	2	14	29	5	0.68
EletronEquip	3	36	56	10	2.15
Automobiles	5	23	14	3	2.03
OthVeicSpare	9	41	25	7	0.75
WoodFurnit	3	21	3	0	0.53
PaperGraph	3	11	5	1	1.20
RubberInd	1	12	13	1	3.31
ChemicElem	1	10	18	3	6.84
PetrolRefin	5	7	13	10	21.68
VariousChem	1	6	17	4	1.22
PharmacPerf	1	5	25	4	1.65
Plastics	1	6	11	1	0.51
Textiles	2	10	10	2	0.56
Apparel	0	2	2	0	0.39
ShoesInd	4	63	7	0	1.31
CoffeeInd	2	22	0	0	3.77

VegetProcess	3	14	4	1	0.95
Slaughter	4	16	1	0	1.36
Dairy	0	1	3	0	2.17
SugarInd	3	37	0	0	3.50
VegetOils	4	29	2	0	5.53
OthAg	2	8	5	1	0.88
VariousInd	1	12	23	2	1.89
PubUtilServ	0	0	3	1	1.77
CivilConst	0	0	0	0	4.09
Trade	1	3	4	1	0.16
Transport	6	14	10	4	0.04
Comunic	0	1	1	0	1.90
FinancInst	1	1	2	1	0.38
FamServic	3	4	7	5	0.10
EnterpServ	6	15	18	9	0.44
BuildRentals	0	0	0	0	46.46
PublAdm	1	1	1	2	0.00
NMercPriSer	0	0	0	0	0.00

Source: IBGE (2001c).

Table 5: Exogenous demand and border price shocks due to trade liberalization in the rest of the world, and the cut in national tariffs, Brazil

(percent change)

	Armington elasticities (Linkage model)	Import tariffs	Import CIF prices	Export FOB prices	Vertical shift in export demand schedule
Coffee	6.5	0.0	0.0	9.0	10.1
SugarCane	5.4	0.0	0.0	0.0	0.0
PaddyRice	10.1	0.0	4.8	0.0	0.0
Wheat	8.9	-0.3	-2.8	7.1	9.3
Soybean	4.9	0.0	1.5	8.1	2.2
Cotton	5.0	0.0	14.4	8.7	8.2
Corn	2.6	0.0	-3.3	8.4	16.2
Livestock	3.9	0.0	1.1	8.9	-9.3
NaturMilk	7.3	0.0	0.0	0.0	0.0
Poultry	2.6	0.0	0.0	8.8	-11.5
OtherAgric	3.7	-2.5	2.2	8.7	4.5
MineralExtr	1.8	-1.7	-2.6	5.6	-10.2
PetrGasExtr	10.4	0.0	-2.6	5.6	-10.2
MinNonMet	5.8	-5.5	0.6	5.1	-0.7
IronProduc	5.9	-5.2	0.6	5.1	-0.7
MetalNonFerr	8.4	-4.5	0.6	5.1	-0.7
OtherMetal	7.5	-8.4	0.6	5.1	-0.7
MachTractor	8.6	-7.4	0.6	5.1	-0.7
EletricMat	8.1	-7.5	0.6	5.1	-0.7
EletronEquip	8.8	-6.4	0.6	5.1	-0.7
Automobiles	5.6	-7.8	0.6	5.1	-0.7
OthVeicSpare	8.6	-5.5	0.6	5.1	-0.7
WoodFurnit	6.8	-7.4	0.6	5.1	-0.7
PaperGraph	5.9	-3.6	0.6	5.1	-0.7
RubberInd	6.6	-8.4	0.6	5.1	-0.7
ChemicElem	6.6	-4.9	0.6	5.1	-0.7
PetrolRefin	4.2	-3.0	0.6	5.1	-0.7
VariousChem	6.6	-5.8	0.6	5.1	-0.7
PharmacPerf	6.6	-4.5	0.6	5.1	-0.7
Plastics	6.6	-9.5	0.6	5.1	-0.7
Textiles	7.5	-11.4	0.1	5.4	1.2
Apparel	7.4	-12.4	0.1	5.4	1.2
ShoesInd	8.1	-6.1	0.1	5.4	1.2
CoffeeInd	2.3	-1.5	7.3	6.1	25.5

VegetProcess	4.0	-2.8	5.9	6.1	25.4
Slaughter	8.4	-1.8	3.7	7.7	25.4
Dairy	7.3	-2.7	10.5	7.0	38.9
SugarInd	5.4	-0.7	0.0	6.5	25.3
VegetOils	6.6	-4.5	-0.8	6.8	-1.3
OthAg	3.8	-5.1	7.3	6.1	25.5
VariousInd	7.5	-7.2	0.6	5.1	-0.7
PubUtilServ	5.6	0.0	-0.2	5.9	-0.7
CivilConst	3.8	0.0	-0.2	5.9	-0.7
Trade	3.8	-1.8	-0.2	5.9	-0.7
Transport	3.8	0.0	-0.2	5.9	-0.7
Comunic	3.8	-1.2	-0.2	5.9	-0.7
FinancInst	3.8	0.0	-0.2	5.9	-0.7
FamServic	3.8	-0.1	-0.2	5.9	-0.7
EnterpServ	3.8	0.0	-0.2	5.9	-0.7
BuildRentals	3.8	0.0	-0.2	5.9	-0.7
PublAdm	3.8	-1.5	-0.2	5.9	-0.7
NMercPriSer	3.8	0.0	-0.2	5.9	-0.7

Source: Linkage model simulations (see Anderson, Valenzuela and van der Mensbrugghe 2010).

Table 6: Macroeconomic impacts of global trade liberalization, Brazil

(percentage change from baseline)

	ROW ag	ROW nonag	Brazil ag	Brazil nonag	Global ag+nonag
Real household consumption	1.05	-0.20	-0.03	-0.15	0.66
Real investment	0.10	-0.02	0.02	0.04	0.14
Real government expenditure	0.00	0.00	0.00	0.00	0.00
Exports volume	0.71	-0.91	0.63	4.85	5.29
Imports volume	5.12	-1.61	0.57	3.84	7.92
Real GDP	0.08	-0.01	0.00	0.03	0.10
Aggregate employment	0.00	0.00	0.00	0.00	0.00
Average real wage	0.43	-0.10	0.34	0.62	1.28
Average real return to farm land	22.43	0.94	3.72	0.86	28.0
Average real return to capital	0.11	0.04	0.34	0.22	0.71
Aggregated capital stock	0.00	0.00	0.00	0.00	0.00
GDP price index	0.23	-0.10	0.06	-0.06	0.13
Consumer price index	0.00	0.00	0.00	0.00	0.00
Exports price index	-0.10	-0.13	-0.25	-0.19	-0.68
Imports price index	-4.28	0.59	-0.20	0.53	-3.37
Terms of trade	4.31	-0.73	-0.05	-0.74	2.78
Real exchange rate	4.66	-0.71	0.27	-0.61	3.62
Nominal GDP	0.31	-0.11	0.06	-0.03	0.22
Nominal land price	22.43	0.94	3.72	0.86	28.00
Gini coefficient[a]	-1.4	-0.1	-0.2	0.1	-1.7
Poverty headcount[b]	-2.3	-0.1	-0.5	-0.4	-3.5

[a] Baseline value is 0.58.

[b] Baseline value is 31 percent.

Source: Authors’ Brazilian CGE model simulations.

Table 7: Effects of global liberalization on sectoral outputs, exports and imports, Brazil

(percentage changes from baseline)

	Output	Exports	Imports
Coffee	12.2	0.0	0.0
SugarCane	18.2	0.0	0.0
PaddyRice	12.6	-82.8	116.6
Wheat	2.2	105.7	16.5
Soybean	3.2	0.5	5.8
Cotton	-2.3	107.8	-16.5
Corn	8.2	10.0	28.3
Livestock	18.0	-76.8	71.6
NaturMilk	6.3	0.0	0.0
Poultry	12.8	-55.0	34.3
OtherAgric	3.5	6.9	4.9
MineralExtr	-12.1	-16.5	-5.9
PetrGasExtr	-4.2	-57.1	-2.7
MinNonMet	-2.6	-15.0	15.9
IronProduc	-9.4	-14.3	11.6
MetalNonFerr	-11.8	-16.2	7.5
OtherMetal	-6.9	-18.4	27.0
MachTractor	-6.6	-23.7	10.8
EletricMat	-5.8	-14.3	9.0
EletronEquip	-4.8	-13.1	1.6
Automobiles	0.8	-5.4	2.6
OthVeicSpare	-11.7	-16.5	10.1
WoodFurnit	-5.5	-23.7	17.8
PaperGraph	-2.8	-17.1.0	10.4
RubberInd	-8.6	-12.9	23.6
ChemicElem	-12.0	-46.4	27.1
PetrolRefin	-1.3	-5.2	3.3
VariousChem	-1.6	-11.6	14.5
PharmacPerf	-0.2	-15.7	3.4
Plastics	-5.0	-13.3	30.3
Textiles	-2.9	9.3.0	35.8
Apparel	0.4	-8.0	21.1
ShoesInd	-12.8	-17.5	14.1
CoffeeInd	14.3	34.3	11.1
VegetProcess	15.1	102.8	1.3
Slaughter	19.0	132.4	45.0

Dairy	7.9	960.3	-20.9
SugarInd	59.6	137.1	22.1
VegetOils	4.5	7.2	4.7
OthAg	8.6	104.3	-0.1
VariousInd	-7.8	-23.7	13.7
PubUtilServ	-1.1	-19.8	8.2
CivilConst	0.0	-13.3	6.0
Trade	1.2	-15.5	8.2
Transport	0.2	-7.7	3.2
Comunic	0.2	-11.1	5.1
FinancInst	-0.3	-10.2	4.7
FamServic	-1.5	-18.9	9.3
EnterpServ	-2.9	-12.3	4.6
BuildRentals	-0.2	0.0	0.0
PublAdm	-0.2	-13.5	6.8
NMercPriSer	-0.8	0.0	0.0

Source: Authors' Brazilian CGE model simulations.

Table 8: Effects of global liberalization on regional output, Brazil

(percentage changes from baseline)

		Real GDP					Aggregate employment
Region	Zone	ROW ag	ROW nonag	Brazil ag	Brazil nonag	Global ag+nonag	Global ag+nonag
Rondonia	N	2.8	0.0	0.3	0.1	3.2	1.5
Acre	N	2.5	0.0	0.3	0.1	2.9	1.3
Amazonas	N	-0.7	-0.1	-0.2	0.5	-0.5	-0.5
Roraima	N	1.7	0.0	0.1	0.1	1.8	0.8
Para	N	1.8	-0.3	0.5	0.0	2.1	1.1
Amapa	N	1.4	-0.2	0.3	0.0	1.5	0.7
Tocantins	N	3.3	0.0	0.3	0.0	3.6	2.3
Maranhao	NE	3.3	0.0	0.4	-0.1	3.6	2.2
Piaui	NE	2.1	0.0	0.3	-0.1	2.3	1.3
Ceara	NE	-0.1	0.3	0.1	0.0	0.2	0.0
RGNorte	NE	-0.3	-0.2	0.0	-0.2	-0.6	-0.2
Paraiba	NE	1.2	0.1	0.3	0.0	1.6	0.7
Pernambuco	NE	1.0	0.0	0.2	-0.1	1.1	0.5
Alagoas	NE	4.6	0.1	1.1	0.0	5.9	2.9
Sergipe	NE	0.3	0.3	0.1	-0.2	0.4	0.2
Bahia	NE	0.4	0.0	0.0	-0.2	0.3	0.2
MinasG	SE	0.5	-0.1	0.1	0.0	0.5	0.2
EspSanto	SE	0.8	-0.4	0.0	0.0	0.4	0.1
RioJaneiro	SE	-0.9	-0.1	-0.2	-0.2	-1.4	-1.0
SaoPaulo	SE	-0.6	0.0	-0.1	0.1	-0.5	-0.5
Parana	S	1.5	0.0	0.2	0.1	1.8	1.0
StaCatari	S	0.6	-0.3	0.1	0.1	0.5	0.7
RGSul	S	-0.3	0.3	-0.1	0.1	0.1	0.1
MtGrSul	CW	4.4	0.1	0.6	0.1	5.2	3.1
MtGrosso	CW	4.2	0.1	0.4	0.1	4.8	3.0
Goias	CW	2.4	0.1	0.4	0.0	2.9	1.8
DF	CW	0.3	-0.1	-0.1	-0.1	0.0	0.0

Source: Authors' Brazilian CGE model simulations.

Table 9: Effects of global liberalization on poverty and income inequality, by household income class, Brazil

(percentage changes from baseline)

Household income class[a]	Average nominal income	Consumer Price Index	Share of group's households below the poverty line	Poverty gap[b]
POF[1]	34.5	0.48	-2.7	-8.3
POF[2]	7.7	0.42	-3.1	-9.4
POF[3]	4.8	0.35	-5.6	-9.4
POF[4]	2.7	0.24	-6.7	-3.5
POF[5]	1.6	0.22	-4.5	9.6
POF[6]	0.5	0.19	7.3	53.9
POF[7]	-0.4	0.10	56.5	313.5
POF[8]	-1.2	0.03	470.4	2032.7
POF[9]	-1.7	-0.12	0.0	0.0
POF[10]	-2.4	-0.36	0.0	0.0
Original values (base year)	-	-	30.8	14.5
Percentage change	-	-	-3.45	-7.59

GINI (percentage change) -1.7

[a] See note a of table 1 for definitions of the income classes.

[b] The percentage by which the group's average household income falls below the poverty line.

Source: Authors' Brazilian CGE model simulations.

Table 10: Decomposition of effects of liberalization on real income, by household income class, Brazil

(percentage changes from baseline)

Household income class[a]	ROW ag	ROW nonag	Brazil ag	Brazil nonag	Global ag+nonag
POF[1]	27.38	2.60	3.80	2.66	34.02
POF[2]	5.56	0.21	0.97	0.46	7.28
POF[3]	3.14	0.21	0.66	0.47	4.45
POF[4]	1.57	0.00	0.42	0.47	2.46
POF[5]	0.69	0.00	0.42	0.48	1.38
POF[6]	-0.25	-0.10	0.20	0.48	0.31
POF[7]	-0.86	-0.10	0.07	0.49	-0.50
POF[8]	-1.45	-0.20	-0.06	0.49	-1.23
POF[9]	-1.74	-0.21	-0.04	0.51	-1.58
POF[10]	-2.11	-0.23	-0.09	0.56	-2.04

[a] See note a of table 1 for definitions of the income classes.

[b] The percentage by which the group's average household income falls below the poverty line.

Source: Authors' Brazilian CGE model simulations.

Table 11: Effects of global liberalization on poverty, by region, Brazil

(percentage changes from baseline)

Region	Share of group's households below the poverty line	Poverty gap[a]
1 Rondonia	-6.3	-7.9
2 Acre	-4.5	-8.5
3 Amazonas	0.1	-0.9
4 Roraima	-5.4	-7.4
5 Para	-4.3	-7.5
6 Amapa	-0.6	-2.3
7 Tocantins	-9.5	-15.6
8 Maranhao	-5.4	-14.2
9 Piaui	-4.2	-8.4
10 Ceara	-2.6	-6.5
11 RGNorte	-3.3	-6.1
12 Paraiba	-4.5	-9.3
13 Pernambuco	-4.5	-9.2
14 Alagoas	-6.9	-14.8
15 Sergipe	-3.6	-6.9
16 Bahia	-2.8	-7.7
17 MinasG	-5.1	-9.2
18 EspSanto	-4.5	-10.7
19 RioJaneiro	2.9	1.9
20 SaoPaulo	1.9	-0.8
21 Parana	-7.1	-11.1
22 StaCatari	-3.9	-6.9
23 RGSul	-6.2	-10.3
24 MtGrSul	-14.3	-19.4
25 MtGrosso	-10.1	-21.3
26 Goias	-8.6	-13.9
27 DF	-0.3	-1.7
	Total number	
Change in total number of poor households (million)	-0.53	
Change in total number of poor persons (million)	-1.94	

[a] The percentage by which the group's average household income falls below the poverty line.

Source: Authors' Brazilian CGE model simulations.

APPENDIX: The method of quantum weights for jobs relocation in the micro-simulation model

Micro-simulation data is naturally discrete: some families have one child, some have 2, but none has 1.5 children. If the micro data survey contains 5000 workers in some occupation for which demand falls by 3 percent, then 150 must be fired. But, which 150? Alternatively, suppose demand rose by 3 percent, creating 150 jobs. Which 150 of the 8000 unemployed in the microdata will get these jobs?

Several approaches have been suggested to deal with this problem. For example, Savard (2003) constructs separate queues of employed and unemployed. The most hirable of the unemployed are the first to get jobs, whilst the least productive workers are fired first. Alternatively, hiring and firing could be allocated randomly.

We pursue a different approach altogether, motivated by the following considerations:

- Our CGE model and microdata identify 11,070 separate firing problems (10 occupations, 27 regions, 41 PNAD sectors) since workers in each family are tagged with these attributes, and 270 hiring problems (since the unemployed have no sector). It would be computationally expensive to construct 11,340 separate queues.
- Perhaps 5000 of the 11,070 different percent changes in employment will be negative. For example, employment by occupation 7 in region 3, sector 18 may fall by 5 percent. Perhaps in the survey data there are only 17 such workers. How do we choose 0.85 (=17*0.05) workers to fire?
- It is typical of CGE simulations that many changes, including many employment changes, are quite small: a subsidy to wheat might cause employment in the plastics sector to fall by 0.006 percent. This exacerbates the previous problem: we may have to allocate many small changes in employment, which correspond to sub-unit changes in the microdata. Rounding to the nearest worker might bias results: we might include the larger employment rises in wheat whilst overlooking the small falls in other sectors. To avoid this we need a procedure for allocating 0.07 jobs in a particular sector and occupation.
- In our PNAD microdata, each observation has a weight, ranging from 150 to 850. We have to take these weights into account when computing totals. It will make a difference whether 1 new job is allocated to a household with weight 200 or with weight 600. This complicates the problem of distributing a discrete number of jobs.

Our procedure makes use of the survey weights to account for non-integer changes in employment, so avoiding the problems just listed. Quantum mechanics teaches that a particle does not have just one location and speed at a certain moment, but is better imagined as a 'probability cloud' showing the likelihood that the particle is in a certain position. Our adoption of the name reflects a feature of our job allocation process described below: instead of trying to decide whether or not a particular worker is fired, we modify our dataset to reflect both possibilities.

Suppose that our survey data file (after it is updated by the CGE model) shows a household, with weight 200, containing only 1 worker and 3 children. We might represent this record as in appendix Table A1. The first row of that table represents household attributes, with an additional row for each adult and his/her attributes. We can see from the JobScore field that employment for workers of this type (Occupation,Sector,Region) has fallen by 5 percent (originally all JobScores were 1.0). In other words this worker is only working 95 percent of a normal job. We can restore the JobScore to an integer value by splitting the household into two records, as can be seen in Appendix Table A2.

Notice that the weights for the 2 new households sum to the original 200. The first household, with weight 190 (=95%*200), is otherwise identical to the original. The adult in the second household (weight 10=5%*200) is unemployed, and has no sector or wage. Although the second household has no income, we still label it as POF group 3; the POF group labels refer to the initial household income group, and are not updated. Our programs are already equipped to deal with differing household weights (the PNAD requires this) so the only inconvenience of the split is that the number of records is increased.

Now suppose our household had two adults, both working in a sector/occupation/region that was declining (JobScore<1), one by 5 percent and the other by 10 percent. To account for Adult 1, 5 percent of the original record must be split off to create a record where Adult 1 has no job. To account for Adult 2, 10 percent of the original record must be split off to create a record where Adult 2 has no job. So we get 3 households: one where both adults are employed, one where adult 1 loses the job, and one where adult 2 becomes unemployed. This example can be seen in Appendix Table A3.

Notice that, taking the weights into account, the splitting preserves both the total employment and total earnings of the original record. However, the variance of family incomes is increased by the split. We could have created a 4th household where both adults lost their jobs – with weight of 1 (=5%*10%*200) – but most of the employment changes were too small to justify this step.

In general, we need to create a new household for each working adult with JobScore>1 and for each unemployed adult with an occupation in increasing demand. Since most households have either one or two adults in the labor force, and about half of the occupation/sector/region labor demands fall, we need to approximately double the number of households. If we took into account unlucky cases such as the 4th household just mentioned, the multiplication of household records could be more severe.

So far we have only examined cases where employment shrank. Consider now the case where employment expands, say, by 5 percent in some sector. We would merely truncate the JobScore to convert this 1, as can be seen Appendix Table A4. No new record is created this time. The lost labor time (0.05*200) and lost wages (0.05*200*250) must be preserved (labeled by region and occupation) for later distribution to the unemployed. Once we have processed all adults in a region, we know how much labor and wages of each type must be distributed to the unemployed. We also know how many unemployed there are of each type (recall, unemployed are assigned to an occupational group). We then pass through the records again, seeking to share out the jobs amongst the unemployed.

Suppose we come upon a record like the one shown in Appendix Table A4. This adult represents 150 unemployed of occupation 3 in Sao Paulo. Suppose in total there were 30,000 such adults, so this adult is 0.5 percent of the total. If there are 20 jobs to distribute, the group represented by this adult should get 0.1 jobs. Therefore we split the record in proportions 149.9/0.1 to get two records, one where the worker is unemployed and the other where the worker is employed, preserving the weight total.

The wage can be worked out since we know how much income we took from over-worked persons of this occupation and region (principle of income conservation). This implies that new workers are assigned an average of the wages paid to this occupation in expanding industries. With the wage given, the sector to which the worker is assigned does not affect income or poverty measures, so need not be known. In fact, we do assign sectors to the newly employed, using a random assignment from expanding sectors, with probabilities weighted according to the size of sectoral employment increases for the relevant occupation and region.

We used a Pascal program to perform the above procedure. Note two potential problems though. One is that the number of new jobs created for a particular region and occupation might exceed the number of unemployed of that type. Potentially the demand for new workers (from the CGE model) might exceed the supply (in the microdata). The problem occurred very rarely in our simulations, mainly for higher-paid occupations in a few regions:

recorded unemployment tends to be low amongst these groups. Since our focus is mainly on lower-paid workers, we are not very concerned. In Brazil there is no shortage of low-skilled labor. Our solution to the problem was to first mop up the unavailable unemployed, then to force workers in the bottleneck occupations to work a little harder (that is, we allowed a few JobScore values to remain above 1).

The second problem is subtle and rare: it occurred in 6 out of the 112,055 original households. Suppose, for a particular region and occupation, that two-thirds of the unemployed are to get jobs. Suppose we have a household weight 300 with two such unemployed. According to the scheme outlined above we would create 2 new household records. The first, with weight 200 (=300*2/3) would allocate a job to Adult 1. The second new record, also with weight 200 would show Adult 2 as employed. Since the sum of weights must not change, the weight now assigned to the original household must be -100! Our solution is to assign a zero weight to the original household and weights of 100 to the 2 new households, meaning that a few unemployed were denied the chance to work. Another solution, mentioned previously, would be to create a third new household in which both adults would get jobs.

Our job allocation procedure does not alter numbers employed or wages earned: it only redistributes jobs and income between adults of the same occupation and region. The effect on income distribution within such a group can be large, but the potential for disagreement with the CGE model results (as computed by Update1) is small, *as long as the job redistribution within occupations does not move income between the POF income groups which drive consumption*. In practice there is a strong correlation between occupational groups (based on individual earnings) and POF income groups (based on household earnings). Hence, job redistribution within occupations affects income distribution within, more than between, POF groups.

Appendix Table A1: Example of a household's attributes

Weight 200	Region: Bahia	Children: 3	POF Group 3				
Adult 1	LF status: employed	wage: 200	JobScore: 0.95	Occupation 3	Sector: Apparel	Age: Y35to39	and so on

Source: Authors' compilation.

Appendix Table A2: Example of the quantum method: job relocation in a household with 1 adult, fall in employment

	ORIGINAL RECORD						
Weight 200	Region: Bahia	Children: 3	POF Group 3				
Adult 1	LF status: employed	wage: 200	JobScore: 0.95	Occupation 3	Sector: Apparel	Age: Y35to39	and so on
	NEW RECORD 1: EMPLOYED						
Weight 190	Region: Bahia	Children: 3	POF Group 3				
Adult 1	LF status: employed	wage: 200	JobScore: 1	Occupation 3	Sector: Apparel	Age: Y35to39	and so on
	NEW RECORD 2: UNEMPLOYED						
Weight 10	Region: Bahia	Children: 3	POF Group 3				
Adult 1	LF status: unemployed	wage: -	JobScore: 0	Occupation 3	Sector: -	Age: Y35to39	and so on

Source: Authors' compilation.

Appendix Table A3: Example of the quantum method: job relocation in a household with 2 adults, fall in employment

	ORIGINAL RECORD							
Weight 200	Region: Bahia	Children: 3	POF Group 3					
Adult 1	LF status: employed	wage: 300	JobScore: 0.95	Occupation 5	Sector: PubUtil	Age: Y35to39	and so on
Adult2	LF status: employed	wage: 200	JobScore: 0.90	Occupation 3	Sector: Apparel	Age: Y35to39	and so on
	NEW RECORD 1: EMPLOYED							
Weight 170	Region: Bahia	Children: 3	POF Group 3					
Adult 1	LF status: employed	wage: 300	JobScore: 1	Occupation 5	Sector: PubUtil	Age: Y35to39	and so on
Adult2	LF status: employed	wage: 200	JobScore: 1	Occupation 3	Sector: Apparel	Age: Y30to34	and so on
	NEW RECORD 2: UNEMPLOYED							
Weight 20	Region: Bahia	Children: 3	POF Group 3					
Adult 1	LF status: unemployed	wage: -	JobScore: 0	Occupation 5	Sector: -	Age: Y35to39	and so on
Adult2	LF status: employed	wage: 200	JobScore: 1	Occupation 3	Sector: Apparel	Age: Y30to34	and so on
	NEW RECORD 3: UNEMPLOYED							
Weight 10	Region: Bahia	Children: 3	POF Group 3					
Adult 1	LF status: employed	wage: 300	JobScore: 1	Occupation 5	Sector: PubUtil	Age: Y35to39	and so on
Adult2	LF status: unemployed	wage: -	JobScore: 0	Occupation 3	Sector: -	Age: Y30to34	and so on

Source: Authors' compilation.

Appendix Table A4: Example of the quantum method: increase in employment

	ORIGINAL RECORD: JOBSCORE > 1						
Weight 200	Region: Parana	Children: 4	POF Group 4				
Adult 1	LF status: employed	wage: 250	JobScore: 1.05	Occupation 3	Sector: AgInd	Age: Y35to39	and so on
	ORIGINAL RECORD: JOBSCORE TRUNCATED						
Weight 200	Region: Parana	Children: 4	POF Group 4				
Adult 1	LF status: employed	wage: 250	JobScore: 1	Occupation 3	Sector: AgInd	Age: Y35to39	and so on

Source: Authors' compilation.