

Structural Change and Poverty Reduction in Brazil: The Impact of the Doha Round

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Abstract

For the Brazilian case, this paper intends to evaluate the poverty effects of possible trade liberalization outcomes of the Doha round in the medium run. This implies to assess the poverty impact of a Doha Round (and a Full Liberalization) counterfactual scenario against a scenario that incorporates some of the main features of medium run structural change. In doing so, we focus on the labor market, as we consider this transmission channel to be of overriding importance in this time horizon. We will thus examine whether the effects of trade liberalization, in particular on poverty and the distribution of income, are still prominent in the medium run.

The main poverty-relevant transmission channels incorporated in our simulation exercise are changes real factor prices and changes in the sectoral composition of the workforce. These changes are driven by changing consumption patterns, differentials in productivity growth rates across sectors, educational upgrading of the workforce, and, finally, the trade shocks. The methodology used here combines a dynamic computable general equilibrium model with a microsimulation model for Brazil. This macro-micro model enables us to analyze the medium-term poverty and distributional impact of different growth patterns in quite some detail.

Our analysis suggests that the economic effects of the Doha round, even of an “optimistic deep” liberalization scenario, are rather limited for Brazil. Accordingly, poverty would remain largely unaffected by this trade reform, which does not appear to be biased in favor any of particularly poor groups. Yet, through a slight improvement in the urban income distribution the Doha scenario has some positive effect on poverty. In contrast, a full liberalization scenario implies quite substantial welfare gains that are concentrated among some of the poorest groups of the country, in particular those in agriculture.

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Table of Contents

1	Introduction.....	3
2	Background and Motivation	5
3	The Modeling Framework	8
3.1	The Macro Model	9
3.2	The Micro Model	17
3.2.1	<i>Estimation</i>	18
3.2.2	<i>Estimation results</i>	22
3.2.3	<i>Simulation</i>	24
3.2.4	<i>Shortcomings</i>	28
4	Brazil in the Next Decade: How Trade Policy Affects a Business as Usual Scenario?.....	29
4.1	The Business as Usual Macro Results	30
4.2	Distributional and Poverty Results for the BaU	32
4.3	Macro results for the full liberalization and the Doha trade policy shocks	37
4.4	Trade Scenarios' Distributional and Poverty Results	44
5	Conclusions.....	54
6	Bibliography	55
7	Appendices.....	58
7.1	Estimation results, mover-stayer model.....	58
7.2	Estimation results, wage/profit equations	60
7.3	Estimation results, labor market segmentation	63
7.4	Poverty lines, in 2001 R\$.....	65
7.5	Macro model' Sectors	65

1 Introduction

Trade liberalization, in particular the liberalization of trade in agricultural products, is considered by many observers as one of the key components of a strategy to reduce poverty worldwide. In their review of the relationship between trade liberalization and poverty, Winters, McCulloch and McKay (2004), conclude that trade liberalization “may be one of the most cost-effective anti-poverty policies available to governments” although it may not be the most powerful. Yet, the complex relationship between trade, growth, distribution and poverty does not allow for a simple conclusion with regard to the impact of trade liberalization on poverty, as the poverty outcomes of trade liberalization may vary substantially from case to case. Despite the complexity of this relationship the evidence so far provides enough insights to predict at least the largest impacts (Winters, McCulloch, and McKay 2004). One of these insights is the importance of the impact of trade liberalization on wages and employment, which depends on the structure and the functioning of the labor market.

For the Brazilian case, this paper intends to evaluate the poverty effects of trade liberalization in the medium run. In doing so, we focus on the labor market, as we consider this transmission channel to be of overriding importance in this time horizon. This implies to assess the poverty impact of a Doha Round (and a Full Liberalization)¹ counterfactual scenario against a scenario that incorporates some of the main features of medium run structural change. We will thus examine whether the effects of trade liberalization, in particular on poverty and the distribution of income, are still prominent in the medium run.

Recent research has demonstrated that growth can differ tremendously in its power to reduce poverty both across countries and over time.² In particular, in high-inequality countries such as Brazil, an apparently slight worsening of the income distribution can imply that growth has very little impact on poverty. It is hence not only important by how much trade liberalization raises incomes, but how it affects the pattern of income growth. The driving forces of this pattern work through the labor market. Among them are

¹ The global trade liberalization scenarios will not be discussed in this paper. The trade shocks that the Brazilian economy faces were developed by a team examining the economic effects of likely Doha negotiation outcomes using a (GTAP-based) global trade model. We will comment only on the changes in tariffs and international prices, as they affect the Brazilian economy. Detailed information on the scenarios and the global trade model used to investigate their economic effects are available from the authors on request, as the project output has not been published yet.

² See Ravallion (2001), Ravallion and Datt (1999) or Kappel, Lay and Steiner (2005).

changes in relative factor prices, but also changes in endowments play an important role in the medium run, as for example the workforce advances its skills. In addition, sectoral employment change can contribute significantly to poverty reduction. Such change in the structure of employment can have very large effects on poverty, as it may enable people to escape poverty traps. There is quite some evidence on the existence of such poverty traps that can arise if occupational or technology choices are discrete and there exist fixed or sunk costs to choosing a higher return occupation or technology (Barrett 2004). Moving out of agriculture where poverty rates are often much higher than in other sectors is one example for such choices. This latter issue is of particular interest in the Brazilian context, as there has been a massive reduction in agricultural employment in recent years, which we consider to be likely to continue. This reduction in agricultural employment may have contributed to poverty reduction, as poverty among agricultural households is considerably higher than among non-agricultural households. Trade liberalization that one would expect to favor agriculture in Brazil may thus work against the “natural” forces of structural change with an adverse impact on poverty reduction. However, trade liberalization may also relieve some of the pressure put on non-agricultural incomes by the reduction in agricultural employment and have some direct poverty reducing effect through raising agricultural incomes.

This last example illustrates the necessity of quantifying each of these transmission channels to evaluate the overall poverty and distributional impact of trade reform. The features incorporated in our simulation exercise are therefore changes in different sources of factor income, changes in the sectoral composition of the workforce, and educational upgrading of the workforce. These changes are driven by changing consumption patterns, purely exogenous factors (at least in our model), such as differentials in productivity growth rates across sectors and differential growth rates for different types of labor, and, finally, the trade shocks. The methodology used here combines a dynamic computable general equilibrium model with a microsimulation model for Brazil. For a time horizon of 15 years, a business as usual scenario and two trade counterfactuals are developed in the CGE model and crucial aggregate results on relative factor prices and resource movements from agricultural to non-agricultural sectors are linked to a microsimulation. This macro-micro model enables us to analyze the long-term poverty and distributional impact of different growth patterns.

The paper is structured as follows. We first provide some background information on the Brazilian case and motivate our approach. Then, we describe the macro and micro modules of the model. The results of our simulations are reported and commented in the following section. The last section summarizes and concludes.

2 Background and Motivation

The main objective of this paper is to assess whether trade reform favors the Brazilian poor. It is therefore important to know who the poor are, where they live, and especially how they earn their living. In addition, it should prove helpful to identify economic trends that have been particularly important for the poor.

Brazil's per capita income has virtually stagnated for the past 25 years and the very unequal distribution of income has remained more or less unchanged. Accordingly, poverty in Brazil has been roughly constant over the past 25 years (Bourguignon, Ferreira, and Lustig 2005; Verner 2004). In light of the substantial structural changes that have occurred in this period, especially increasing urbanization, a massive decline in agricultural employment, increasing unemployment, an important educational expansion and demographic changes, this appears "paradoxical", as Bourguignon et al. (2005) put it. Yet, microsimulation exercises by Ferreira and Paes de Barros (2005) show that each of the features of structural change affects poverty and inequality, but they tend to cancel out each other.³

Poverty in Brazil varies considerably between regions, rural and urban areas, and city sizes with poverty being particularly high in rural areas, small and medium towns and the metropolitan peripheries of the North and the Northeast (Ferreira, Lanjouw, and Neri 2001). In 1996, the North and the Northeast accounted for 55 percent of the poor and for 34 percent of the Brazilian population. At the national level, about 20 percent of the population lived in rural areas contributing 35 percent to total poverty.⁴ The high poverty rates in rural areas, particularly in the Northeast, are related to this region's predominance of employment in agriculture. The Northeast has the highest share of agriculture in employment with 34 percent in 2001 compared to only 11.5 percent in the Southeast.⁵ According to Ferreira, Lanjouw, and Neri (2001), 20 percent of all households had a household head employed in agriculture and these households contributed 34 percent to overall poverty in 1996.

Yet, not only do poverty levels differ across regions, rural and urban areas, and activities, but also do the changes in poverty. Verner's (2004) PNAD-based⁶ figures suggest that the

³ Note that their analysis compares the income distribution of 1976 with the 1996 distribution. For detailed results see Ferreira and Paes de Barros (2005).

⁴ Poverty is measured by the headcount ratio. The poverty figures in this paragraph are taken from Ferreira, Lanjouw, and Neri (2001).

⁵ The figures on agricultural employment are own calculations based on the PNAD 1997 and the PNAD 2001.

⁶ The PNAD (Pesquisa Nacional por Amostra de Domicílios) is a regularly conducted representative household survey. The sample had a size of about 380 000 individuals in 2001.

poverty headcount in the Northeast declined from almost 60 percent in 1990 to 42.3 percent in 2001, whereas poverty in Brazil's most populous state Sao Paulo rose slightly from 8.6 to 9.4 percent during the same period. For urban areas, Ferreira and Paes de Barros (2005) show that extreme poverty increased between 1976 and 1996. According to Paes de Barros (2004) however, the poverty incidence in rural areas in general and among households engaged in agricultural activities, in particular, declined from levels of about 60 percent to around 50 percent between 1992 and 2001.

One important factor for understanding these developments are the structural changes in Brazilian agriculture in the 1980s and 1990s. These changes have certainly had a profound impact on rural livelihoods and poverty in Brazil, but they may also have affected urban areas for example by putting pressure on urban labor markets through increased migration. With the exception of Paes de Barros (2004), research efforts in this direction however have focused on agricultural performance rather than on how this performance affects people's livelihoods. In their assessment of the impact of sector-specific as well as economy-wide reforms on Brazilian agriculture, Helfand and Rezende (2004) conclude that agriculture became one of the most dynamic sectors in the Brazilian economy. Between 1980 and 1998 real GDP grew by about 40 percent and real agricultural output by about 70 percent. In many sub-sectors, yields increased significantly and more harvested area was dedicated to exportables, in particular soybeans and sugarcane. Agriculture benefited from a conducive macroeconomic environment and trade reforms that led to less industrial protection and the elimination of taxes and quantitative restrictions on agricultural exports. In addition, specific agricultural reforms – in particular a reform of agricultural credit and price support policies; an agrarian reform program, including a land reform; and, finally, the deregulation of domestic markets for agricultural goods – were important drivers of the observed agricultural performance.⁷ The increase in agricultural productivity however was accompanied by a massive lay-off of hired labor and by important changes in the size distribution of farms. According to the agricultural census from 1996, the number of small farms declined dramatically and agricultural employment shrank by 23 percent between 1986 and 1996, although these figures should be taken with caution (Helfand and Rezende 2004). Non-agricultural activities appear to have compensated for the loss in agricultural employment in rural areas, but unemployment rates in urban areas with a previously important share of agricultural labor have risen in that period (Dias and Amaral 2002). Our analysis based on the 1997 and 2001 household surveys (PNAD)

⁷ See Helfand and Rezende (2004) and Dias and Amaral (2002) for details.

suggests that this decline in agricultural employment has continued after 1996. In 2001, agriculture accounted for 20.6 percent of employment in Brazil down from 24.2 percent in 1997. Unemployment in rural areas has stayed constant at about 2.5 percent during this period, whereas urban unemployment has risen quite considerably from 9.44 to 10.6 percent, an increase that may be related to the decline in agricultural employment.⁸ Less agricultural employment opportunities may also be one of the reasons for further urbanization in Brazil although it is difficult to establish this link empirically, as we explain in more detail later. The rural population declined quite dramatically from 24.41 percent in 1991 to 21.64 percent in 1996 (IBGE 1997) and 16 percent in 2001 (PNAD 2001). The trends in rural poverty mentioned above suggest that the described developments have improved rural livelihoods. Nevertheless, poverty rates in rural areas remain well above urban poverty rates.

Future developments in agriculture are not known with certainty, but it is likely that some of the observed trends, in particular the decline in agricultural employment and the related, though very small, increase in incomes from agriculture, will continue. We therefore incorporate them in our Business as Usual (BaU) scenario, against which the trade reform scenarios are to be judged. The BaU scenario should hence provide a quantitative assessment of the poverty and income distribution effects of these possible future developments. Trade liberalization may have important consequences in this regard through potentially favoring export-oriented agricultural sectors, possibly offsetting at least some of the decrease in agricultural employment, and increasing agricultural incomes.

So far, we have been mainly concerned with the rural poor and the developments in the agricultural sector. More than two thirds of the Brazilian poor however either live in urban areas or from income earned in non-agricultural sectors. They may have been only indirectly affected by the intersectoral resource shifts just described, for example through downward pressure on non-agricultural wages because of labor released from agriculture. Ferreira and Paes de Barros (2005) find the abovementioned increase in extreme poverty in urban Brazil to be related to rising unemployment and informality. In addition, lower labor market returns contributed to higher poverty. These negative effects on poverty were partially offset by demographic developments, but mainly by educational expansion. In this regard, it should also be noted that low levels of education are an

⁸ Data from employment histories in the PNAD reveal that in both 1997 and 2001 about 6 percent of those who became unemployed in the last year were employed in agricultural sectors before. Taking into account that approx. 20 percent of the workforce are employed in agriculture, this figure is rather low and may be taken as a sign that the rise in urban unemployment is not causally linked to the decline in agricultural employment.

important determinant of poverty in Brazil. Educational expansion has hence become a major policy focus of the Brazilian government for good reasons.⁹ Better education, in particular for the poor, is of course only one of the many factors that decide upon whether and how the poor benefit from growth. Social conflict and crime, deficient public service delivery as well as unemployment, in particular youth unemployment and a high share of informal work relations and self-employment are pressing problems in the metropolitan areas and their peripheries. Some of the latter issues certainly go beyond the scope of our analysis, but the decline of the informal sector as well as urban unemployment are key factors for poverty reduction. The poverty incidence among informal sector employees and the urban self-employed is almost as high as among rural self-employed (Elbers, Lanjouw, Lanjouw and Leite 2004).

Unfortunately, it is very difficult to empirically model the informal economy and formal-informal linkages without making very crude assumptions, for example on informal technologies, which is why we decided not to model informal activities explicitly. With regard to trade liberalization, it may of course well be that informal and formal activities are affected differently by trade reform, due to differences in technologies as well as export-orientation. Furthermore, our model is a full-employment model and we hence disregard unemployment, which may also arise, at least transitorily, due to trade liberalization. Admittedly, our poverty impact analysis may therefore miss some of the transmission channels through which trade liberalization affects especially the urban poor. We do however make an attempt to represent further educational expansion in our simulations.

All in all, our analysis hence addresses the poverty and distributional impact of a subset of features of structural change that we consider particularly relevant for the Brazilian case (and possibly beyond Brazil), most importantly further structural change in agriculture, and how these features interact with trade policies.

3 The Modeling Framework

The model consists of a sequentially dynamic CGE model that is linked to a microsimulation. The microsimulation takes the changes in factor and goods prices as given; hence, there is no feedback between these two parts of the model. We consider this framework particularly suited for the questions at hand, as the CGE model captures some

⁹ The Bolsa Escola Program, a means-tested conditional cash transfer program that reaches 6 million households in Brazil, is one of the major policy instruments in this regard. See Bourguignon, Ferreira and Leite (2002) for an assessment of Bolsa Escola using a microsimulation model.

of the main features of structural change and the relative price changes accompanying them. The microsimulation then allows for a detailed empirical assessment of the household responses to these changes. As will become clear in the following, the major advantage of the microsimulation is that its micro unit is the individual rather than the household, which offers much richer ways of representing distributional dynamics.

3.1 The Macro Model

A 1997 Social Accounting Matrix (SAM) has been used as the initial benchmark equilibrium for the CGE model. This SAM has been assembled from various sources incorporating data from the 1997 Input Output table, information from the SAM assembled by Harrison, Rutherford, Tarr, and Gurgel (2003), and the 2001 PNAD household survey. For the purposes of this model the full SAM – which includes 41 sectors, 41 commodities, 12 factors (skilled and unskilled labor by gender and by farm and non-farm occupation, agricultural and non-agricultural capital, land and natural resources), an aggregate household account, and other accounts (government, savings and investment, and rest of the world)¹⁰ – has been aggregated to a smaller size and it comprises the accounts shown in Table 1.

Table 1: CGE Model accounts

Model Sectors		
1 CerealGrains	7 OilMinerals	13 MachineryEquipment
2 OilSeeds	8 LightManufacturing	14 OtherServices
3 RawSugar	9 AgriIndustriesExp	15 Construction
4 OthCrops	10 WoodProductsPaper	16 TradeCommunication
5 Livestock	11 ChemicalsOilPr	17 PublicServices
6 RawAnimalProducts	12 MetalMineralProducts	
Factors of Production		
18 Land	21 Non agriculture Unskil. Lab	23 Agriculture Unskil. Lab
19 Natural Resources	22 Non agriculture Skilled Lab	24 Agriculture Skilled Lab
20 Capital		
Other Accounts		
25 Production Taxes	29 Direct Taxes	32 Investment-Savings
26 Indirect Taxes	30 Households	33 Variation of Stocks
27 Tariffs	31 Government	34 Rest of the World
28 Export Taxes		

The CGE model is based on a standard neoclassical dynamic general equilibrium model and the following subsections describe its main features. Given our focus on labor markets and dynamic structural trends, more detailed explanations are provided on the modeling of factor markets and growth.

¹⁰ See annex for a full list of accounts.

Production. Output results from nested CES (Constant Elasticity of Substitution) functions that, at the top level, combine intermediate and value added aggregates. At the second level, on the one hand, the intermediate aggregate is obtained combining all products in fixed proportions (Leontief structure), and, on the other hand, value added results by aggregating the primary factors. At this level, primary factors are a capital-labor bundle and aggregate land. Lower levels disaggregate capital and labor, and then labor into different categories.

Income Distribution and Absorption. Labor income and capital revenues are allocated to households according to a fixed coefficient distribution matrix derived from the original SAM. Notice that one of the main advantages of using the micro-module is to enrich, as described above, this rather crude macro distribution mechanism. Private consumption demand is obtained through maximization of household specific utility function following the Linear Expenditure System (LES). Private savings are a fixed proportion of income. Once the total value of private consumption is determined, government and investment demands¹¹ are disaggregated in sectoral demands according to fixed coefficient functions.

International Trade. The model assumes imperfect substitution among goods originating in different geographical areas.¹² Imports demand results from a CES aggregation function of domestic and imported goods. Export supply is symmetrically modeled as a Constant Elasticity of Transformation (CET) function. Producers decide to allocate their output to domestic or foreign markets responding to relative prices. The assumptions of imperfect substitution and imperfect transformability grant a certain degree of autonomy of domestic prices with respect to foreign prices and prevent the model from generating corner solutions. This single country Brazilian model has been linked to a global CGE model by adding export demand functions so that the increased market access accompanying multilateral trade liberalization scenarios can be simulated more precisely. In particular, export demands have been implemented as shown in equation (1) and, during a trade policy simulation, to mimic the quantity and price shocks resulting from the global model, both the intercept α_k^e and the price level $WPEindex$ are changed accordingly.

¹¹ Aggregate investment is set equal to aggregate savings, while aggregate government expenditures are exogenously fixed.

¹² See Armington (1969) for details.

$$ED_k = \alpha_k^e \left(\frac{\overline{WPEindex_k}}{WPE_k} \right)^{\eta_k^e} \quad (1)$$

No international import supply functions have been added and Brazil is a price taker for its imports. The balance of payments equilibrium is determined by the equality of foreign savings (which are exogenous) to the value for the current account.

Factor Markets. Labor is distinguished into 2 categories: skilled and unskilled. These categories are considered imperfectly substitutable inputs in the production process; moreover, some degree of market segmentation is assumed: capital and land are perfectly mobile across sectors, and natural resources are sector specific, and labor markets for the unskilled are segmented between agriculture and non-agriculture, whereas skilled workers are fully mobile.

The labor market specification is a key element of our model and an important driver of poverty and distributional results. Therefore, its specification calls for some clarification and justification. Before we enter a discussion on the specific assumptions of our model, we shortly define labor market segmentation, as the applied modeling literature often handles this term rather sloppy.¹³ A common misunderstanding is that a labor market is segmented if one can identify “segments” with different wage-setting mechanisms, for example due to efficiency wages being paid to some segment of the workforce. Yet, different wage-setting causes wage rigidity that implies (price) rationing, but not segmentation. Such rationing due to different wage-setting may well be observed in an efficient, smoothly functioning labor market.¹⁴ A segmented labor market however does not work smoothly, as labor market mobility is limited and this puts constraints on the adjustment of the supply side. Such constraints could for example be deficiencies in educational systems that prevent unskilled workers from acquiring more skills despite an increasing wage gap between unskilled and skilled labor.

As mentioned above, we assume that the labor market is segmented into unskilled and skilled labor. We think that this has become a standard assumption in CGE modeling for good reasons. The inequalities of the Brazilian society also in terms of educational endowments and more importantly, access to education and on-the-job training, certainly justify this assumption even over medium-term time horizons.

¹³ See Taubman and Wachter (1986) for a general discussion of labor market segmentation.

¹⁴ Note that rationing might of course well be inefficient if is for example due to government interventions.

In addition, we assume that the market for unskilled labor is further segmented into agricultural and non-agricultural activities. This is without doubt a more controversial assumption, in particular in light of its importance in terms of poverty and distributional results. An obvious first check of this assumption is whether incomes in agriculture are really lower in agriculture once we control for all the “usual suspects” of wage determination, including education, experience, gender, racial dummies, other than sectoral employment-related variables, such as self-employment, being employed in the informal sector, or working only seasonally, and geographical variables that capture differences between the Brazilian regions as well as between rural and urban areas. Note that these geographical variables also capture spatial price differentials. Taking the largest non-agricultural sector in terms of employment, “other services”, as a reference group, an OLS regression shows that individual labor incomes are significantly lower in all agricultural sectors except the oil seeds and the sugar cane sector, which only account for approximately 6 percent of agricultural employment. The regression results are reported in appendix 7.3. Note that labor incomes in all non-agricultural sectors, with the notable exception of agricultural processing, are significantly higher than in “other services”.

There can be a number of reasons for observing this income gap between agricultural and non-agricultural employment. A first explanation could be that agricultural income, in particular from self-employment, is systematically underreported. Yet, the regression results suggest that there is no underreporting problem for the self-employed, as for example both the dummy for self-employment and the dummy for being a landowner¹⁵ turn out to be significantly positive. It can be argued at this point that these dummies reflect the returns to land, and underreporting may still be present. Even if so, we also do not see a reason why there should be systematically more underreporting among the wage-employed in agricultural than among those in non-agricultural sectors.

Another reason for the sectoral income differential may lie in positive externalities associated to agricultural employment. Examples of such externalities include food self-sufficiency or employment opportunities for other family members. Yet, you can also easily think of negative externalities of agricultural employment, such as the exposure to weather shocks or hard physical work. These externalities are difficult if not impossible to quantify, but we think that we can plausibly assume that positive and negative externalities tend to cancel each other out.

¹⁵ More than 60 percent of the agricultural self-employed work on their own land.

If we accept that there is an income differential between agriculture and non-agricultural sectors, the question is why individuals do not respond to this differential and move to the non-agricultural sector until incomes in both sectors are equalized. There must hence be barriers to mobility between agricultural and non-agricultural employment that prevent people from moving out of the agricultural sector. When thinking about limited mobility and the reasons behind it, the time horizon of the analysis is an important issue. It should be borne in mind that the time span considered here is approximately 15 years. A very important factor also in the medium run is that many people in the agricultural sector own land. Smallholders who own their own land and non-remunerated family members on these farms account for approximately 40 percent of agricultural employment in Brazil. There may be important externalities related to land ownership, such as economic independency. Some smallholders may not sell the land they own because of a bequest motive. The specificity of human capital acquired in the agricultural sector may also play an important role in making people stay in the agricultural sector. In addition, risk aversion may also prevent people from switching from agricultural to non-agricultural activities since they will only on average gain more in non-agricultural sectors. The estimations for our microsimulation model that we comment in more detail later lend empirical support to some of these hypotheses. In particular, we find that land ownership prevents individuals from moving out of the agricultural sector.

The implementation of dual labor markets for *unskilled* workers follows the standard Harris-Todaro specification where the decision to migrate is a function of the expected income in the non agricultural (urban, in the original formulation) segment relative to the expected income in the agricultural (rural) segment. The specification deviates somewhat from Harris-Todaro. First, relative wages are used as a proxy for relative incomes. Second, actual wages determines migration rather than expected wages in the absence of unemployment. The basic migration equation has the form given in equation (2), where *MIGR* represents the level of migration between segments. Note that the index *l* indicates the skill level (*l* = unskilled), and the index *g* represent the segment (*g* = agriculture or non-agriculture).

$$MIGR_l = \chi_l^m \left[\left(\frac{AWAGE_{Nagri,l}}{AWAGE_{Agri,l}} \right)^{\omega_l^m} - 1 \right] \quad (2)$$

$$AWAGE_{g,l} = \frac{\sum_{i \in g} \left(\frac{W_{i,l}}{1 + \tau_{i,l}^f} \right) L_{i,l}^d}{\sum_{i \in g} L_{i,l}^d} \quad (3)$$

The variable $AWAGE$ is the average wage in the respective segments and is given by equation (3). The average wage is calculated based on the net-of-tax wage rate, the rate which matters to the worker deciding to migrate or not.

Labor market equilibrium conditions are based on two separate labor markets rather than the integrated market of the skilled workers. Equation (4) determines the equilibrium wage rate by segment—i.e. agriculture and non-agriculture. It sets the aggregate segment labor supply equal to the demand for labor in the same segment, i.e. it determines the variable W^e which is now indexed by both segment index as well as labor type. The model allows for inter-sectoral wage differentials, but these are exogenous in the standard model. Equation (5) evaluates the relative wages with respect to the segment-specific equilibrium wage.

$$L_{g,l}^s = \sum_{i \in g} L_{i,l}^d \quad (4)$$

$$W_{i,l} = \phi_{i,l}^l W_{g,l}^e \quad \text{for } i \in g \quad (5)$$

The remaining loose end is the definition of labor supply and this is given by equations (6) and (7). It is assumed that labor supply net of migration is given in any given period. In the dynamic scenario, labor supply in each segment grows at the same exogenous rate, g^L and migration is subtracted from this amount in the agricultural segment, equation (6), and is added to labor supply in the non-agricultural segment, equation (7). Equation (8) determines the total economy-wide labor supply for each labor type.

$$L_{Agri,l}^s = (1 + g_l^L) L_{Agri,l,-1}^s - MIGR_l \quad (6)$$

$$L_{Nagri,l}^s = (1 + g_l^L) L_{Nagri,l,-1}^s + MIGR_l \quad (7)$$

$$L_{Tot,l}^s = L_{Agri,l}^s + L_{Nagri,l}^s \quad (8)$$

Model Closures. The equilibrium condition on the balance of payments is combined with other closure conditions so that the model can be solved for each period. Firstly consider the government budget. Its surplus is fixed and the household income tax schedule shifts in order to achieve the predetermined net government position. Secondly, investment must equal savings, which originate from households, corporations, government and rest of the world. Aggregate investment is set equal to aggregate savings, while aggregate government expenditures are exogenously fixed.

Growth equations. Sectoral shifts among agriculture and non-agriculture and human capital upgrading are two of the main features that have characterized recent growth processes in Brazil, and indeed in most developing nations. To capture these features in a transparent and simple dynamic framework, productivity growth calibration is different for the agriculture and non-agriculture sectors. Equation (9) defines the growth rate of GDP at market price and equation (10) is a formula expressing a balanced growth, where capital to labor ratio in efficiency units is constant.

$$RGDPMP = (1 + g^y) RGDPMP_{-1} \quad (9)$$

$$\frac{\sum_{kt} \sum_i \lambda_{i,kt}^k K_{i,kt}^d}{\sum_l \sum_i \lambda_{i,l}^l L_{i,l}^d} = \frac{\sum_{kt} \sum_i \lambda_{i,kt,0}^k K_{i,kt,0}^d}{\sum_l \sum_i \lambda_{i,l,0}^l L_{i,l,0}^d} = \chi^{kl} \quad (10)$$

Equation (11) and (12) determine the growth rates of labor and capital productivity for the non-agricultural sectors (subscript *nag*). The growth rates have two components, a uniform factor applied in all sectors to all types of labor and capital, γ^l and γ^k , and a sector- and factor-specific factor, χ^l and χ^k . In defining a baseline, the growth rate of GDP is exogenous, as well as the capital to labor ratio. In this case, equation (9) is used to calibrate the γ^l parameter and equation (10) calculates the common growth rate for capital productivity, γ^k . In policy simulations, γ^l and γ^k are given, and equation (9) defines the growth rate of GDP, whereas equation (10) estimates the capital output ratio.

$$\lambda_{nag,l}^l = (1 + \gamma^l + \chi_{nag,l}^l) \lambda_{nag,l,-1}^l \quad (11)$$

$$\lambda_{nag,kt}^k = (1 + \gamma^k + \chi_{nag,kt}^k) \lambda_{nag,kt,-1}^k \quad (12)$$

Productivity growth in agriculture is treated differently. As already mentioned, in the last decade, Brazilian agriculture recorded high productivity growth, and we impose exogenous growth rate for productivity in agriculture uniformly across all factors, as shown in the following equations. Equation (13) represents the increase in labor productivity in agricultural sectors not subject to the uniform productivity shift factor γ^l . Equations (14) through (16) update productivity of capital, land and the sector specific factor, respectively. With agricultural productivity assumed to be uniform across all factors of production, the growth parameters χ^l , χ^k , χ^t , χ^γ will be the same for all agricultural sectors.

$$\lambda_{ag,l}^l = (1 + \chi_{ag,l}^l) \lambda_{ag,l,-1}^l \quad (13)$$

$$\lambda_{ag,kt}^k = (1 + \chi_{ag,kt}^k) \lambda_{ag,kt,-1}^k \quad (14)$$

$$\lambda_{ag,lt}^t = (1 + \chi_{ag,lt}^t) \lambda_{ag,lt,-1}^t \quad (15)$$

$$\lambda_{ag}^\gamma = (1 + \chi_{ag}^\gamma) \lambda_{ag,-1}^\gamma \quad (16)$$

Additional support for a sector specific treatment of productivity where agriculture shows total factor productivity (TFP) growth rates higher than those for manufacturing comes from a recent panel study on sectoral productivity growth in OECD and developing countries.¹⁶ In this study, depending on the estimation method, the average growth rate for agricultural TFP in middle-income developing countries ranges from 1.78 to 2.91 (in % per year).

Other elements of simple dynamics include exogenous growth of labor supply, with skilled labor growing faster than unskilled labor, and investment driven capital accumulation.¹⁷

Equation (17) determines labor supply growth for the skilled workers (unskilled labor supplies are determined in equations (6) and (7)). It simply applies an exogenous assumption about the growth of labor supply, g^{ls} , to the labor supply shift parameter.

¹⁶ See Martin and Mitra (1999).

¹⁷ Note that public investment, in this version of the model, has no impact on production technology.

Equation (18) updates population. Equations (19) and (20) are similar growth equations for land and the sector-specific resource, respectively.

$$\alpha_l^{ls} = (1 + g_l^{ls}) \alpha_{l,-1}^{ls} \quad (17)$$

$$Pop = (1 + g^{Pop}) Pop_{-1} \quad (18)$$

$$Land = (1 + g^l) Land_{-1} \quad (19)$$

$$\gamma_i^{nr} = (1 + g_i^{nr}) \gamma_{i,-1}^{nr} \quad (20)$$

Capital accumulation is based on the level of investment of the previous period less depreciation. Equation (21) represents the motion equation for capital growth, where δ is the rate of depreciation and KAP is the capital stock.

$$KAP = (1 - \delta) KAP_{-1} + XF_{Zlp,-1} \quad (21)$$

Other exogenous variables may require updating for the baseline. One obvious one is government expenditure. This is typically assumed to grow at the same rate as GDP:

$$\overline{XF}_{Gov} = (1 + g^y) \overline{XF}_{Gov,-1} \quad (22)$$

Other variables that have been updated include the various transfer variables, foreign savings, exogenous world prices (i.e. the terms of trade), and fiscal policies.

3.2 The Micro Model

The micro model is linked to the macro model through changes in the following set of endogenous (in the CGE model) variables: (a) changes in agricultural and non-agricultural labor income of unskilled labor (2 variables); (b) changes in labor income of skilled labor (1 variable); (c) changes in the sectoral (agriculture vs. non-agriculture) composition of the unskilled workforce (1 variable). In addition, we take into account that unskilled and skilled labor supplies grow at different rates. In the microsimulation, we do not produce a series of cross-sections through time, but only simulate one cross-

section that reflects the cumulative changes in the aforementioned exogenous and endogenous variables between 2001 and 2015.

In accordance with the structure of the CGE model, the micro model treats skilled and unskilled labor differently and, in particular, simulates the decision to move from agriculture into non-agricultural sectors only for unskilled workers.

In the following, we first illustrate the equations to be estimated to serve as a basis for the microsimulation and we report and comment on some estimation results. Then, we outline the microsimulation module that combines (static) reweighting methods to reflect the changes in the composition of the labor force, i.e. the unskilled/skilled labor ratio, and (dynamic) behavioural elements to simulate the sectoral movements and wage changes given by the CGE. We conclude this section by pointing towards possible shortcomings of the data and the methods applied.

3.2.1 Estimation

First, we estimate sectoral mover-stayer models for unskilled heads and non-heads separately. For both heads and non-heads, we observe whether an individual has moved from agriculture into a non-agricultural sector. Our sample hence consists of those individuals who are still in agriculture and those who have moved out of agriculture within the last year.

In contrast to many other household surveys, the PNAD provides information on employment histories, which allows us to identify the movers out of agriculture and, very important for our undertaking, the characteristics of the movers at the time of moving. For all the movers we thus know, for example, which type of land right they had if they were self-employed before they moved out of agriculture. To our knowledge, this information has not been explored to date. The estimated model hence combines the idea of the mover-stayer model from the migration literature¹⁸ with the approach to modeling occupational dynamics typically applied in income generation microsimulations.¹⁹ In the latter approach, bi- or multinomial choice models are estimated on the entire population. In our case, this would imply comparing the characteristics of those in agriculture with those in non-agricultural sectors. Instead, the mover-stayer model compares the characteristics of only the movers with those of the stayers. This appears to be more appropriate in the current setting, as our goal is to simulate the transition from agriculture to non-agriculture.

¹⁸ See for example Nakosteen and Zimmer (1980).

¹⁹ See for example Robilliard, Bourguignon, and Robinson (2001) and Bussolo and Lay (2003).

Let *move* be a dichotomous variable that assumes a value of 1 if the individual has moved out of agriculture in the last year, and 0 if the individual has stayed in agriculture. As indicated by equation (23), an individual will move (*move* = 1) if the utility (*U*) associated to this choice is higher than the utility of staying in agriculture.²⁰ Otherwise, the individual will stay in agriculture (24).

$$move = 1 \text{ if } U(move=1) > 0 \quad (23)$$

$$move = 0 \text{ otherwise.} \quad (24)$$

As indicated by equations (25) and (26), the utility of moving depends on a set of explanatory variables *X* and a random error term ε . We hence assume a linear relationship between utility and the explanatory variables. The subscripts *msh* and *msnh* refer to heads and non-heads, respectively. They also serve to remind us that the parameters and variable vectors are from the mover-stayer (*ms*) model.²¹

$$U(move = 1)_{msh} = \alpha_{msh} + X_{msh} \beta_{msh} + \varepsilon_{msh} \quad (25)$$

$$U(move = 1)_{msnh} = \alpha_{msnh} + X_{msnh} \beta_{msnh} + \varepsilon_{msnh} \quad (26)$$

where X_{msh} includes an educational dummy for more than 10 years of schooling, age, a dummy that refers to own-consumption worker, an employment category to our knowledge unique to the PNAD that describes workers who are not self-employed, do not receive any monetary income, and work “for their own consumption”²², two dummies that refer to the type of land right held by the self-employed in agriculture, one referring to a situation, in which the landowner agrees with the self-employed occupying the land and another to the self-employed owning the land, and a regional dummy for the northern region. X_{msnh} for the non-heads is a vector of similar variables, but some notable differences that will be discussed later in the regression results section. It consists of three educational dummies, experience (age-schooling-6), experience squared, a female dummy, a dummy for blacks, and the same employment category and land right dummies

²⁰ The utility of staying in agriculture is assumed to be 0. This is typical identifying assumption of the logit.

²¹ We do not use a subscript for indicating individual observations in the exposition of the micromodel for illustrative purposes.

²² See Notas Metodológicas PNAD 2001.

as before plus a dummy for non-remunerated family members or workers. Note that the reference group for the employment-related dummies are the wage-employed. In addition, the explanatory variables for the non-heads include a dummy for the household head being employed in a non-agricultural sector and another dummy for the head being a mover out of agriculture.

As we cannot observe the latent utility U , the parameters of the mover-stayer model will be estimated by maximum likelihood logit techniques, i.e. we estimate the models described by equations (27) and (28), where F denotes the cumulative density function of the logistic distribution.

$$\text{Prob}(\text{move}_{msh} = 1 | X_{msh})_{msh} = F(\alpha_{msh} + X_{msh}\beta_{msh} + \varepsilon_{msh}) \quad (27)$$

$$\text{Prob}(\text{move}_{msnh} = 1 | X_{msnh})_{msnh} = F(\alpha_{msnh} + X_{msnh}\beta_{msnh} + \varepsilon_{msnh}) \quad (28)$$

In addition to the sectoral choice model, Mincer wage/profit equations for unskilled labor in agriculture (the subscript $uagr$) and non-agriculture ($unagr$), and for skilled labor (s) are estimated:

$$\ln w_{uagr} = \alpha_{uagr} + X_{uagr}\beta_{uagr} + uw_{uagr} \quad (29)$$

$$\ln w_{unagr} = \alpha_{unagr} + X_{unagr}\beta_{unagr} + uw_{unagr} \quad (30)$$

$$\ln w_s = \alpha_s + X_s\beta_s + uw_s \quad (31)$$

where the explanatory variables in all three equations include years of education, experience, the corresponding squared terms, a female dummy and racial dummies. In addition, we include regional dummies that in equations (30) and (31) also differentiate between rural and urban areas. In the equation for the unskilled in agriculture (29), we introduce a dummy for being self-employed and the number of non-remunerated family members in order to capture their labor input. The wage/profit equations (29) to (31) are estimated using Ordinary Least Squares (OLS).

Some words on the choice of this specification are in order, as estimating the two wage equations for unskilled labor using OLS may appear problematic to the reader who is familiar with the concept of selectivity bias and is aware of the available econometric

methods to deal with it. The reason for estimating two wage equations is based on the assumption that the wage-setting process in agriculture is different from the one in non-agricultural sectors; and the results of our regressions confirm this assumption. When estimating two separate equations we therefore might have to account for selectivity bias. Selectivity bias refers to a bias in the coefficients of the wage equations which arises as the coefficients do not merely reflect the returns to education, seniority, or the influence of the included dummies, but also the returns of being employed in (or selected into) the respective sector. For example, having a high level of education affects the sectoral choice, i.e. the earnings indirectly, as well as the earnings directly. Applying OLS to the estimation of two separate (sectoral) wage equations would result in coefficients that reflect both the indirect (selection) and the direct effects. Selection can also be interpreted in terms of having a kind of “comparative advantage” in the chosen sector, which is not explicitly accounted for but represented by the biased OLS coefficients. Econometricians often describe the concept of selectivity by noting that the selection into the respective sectors is non-random. It has become very common to correct for selectivity bias using the so-called Heckman correction or one of its many variants.

Many authors have warned against the indiscriminate use of the selectivity correction methods.²³ In line with this general skepticism, for reasons that have to do with the purpose of estimating the above equation, and due to practical estimation problems, we believe that correcting for selectivity bias is not necessary or may even lead to wrong results in the present context. The purpose of estimating the wage equations is to impute earnings for those who move between sectors. If we estimate the wage equation using OLS we implicitly assume that the returns to education and other characteristics of the individual include the indirect returns due to selection. We believe that this can be reasonably assumed, as an individual, for whom a wage is to be imputed, is actually selected into the corresponding sector.²⁴ In addition, estimating a selection model rendered inconsistent results. The only feasible estimation strategy would then have been to reduce the number of explanatory variables in the wage equation to include only one educational dummy for tertiary education with the remaining educational dummies to be only included in the selection equation.²⁵ This of course would have been highly

²³ See Johnston, Di Nardo (1997, pp.449-450) for a short overview of the major problems involved and the citations there.

²⁴ This assumption implies that there are no differences between individuals in terms of sectoral comparative advantages. If we estimated the wage equation correcting for selectivity, these differences would be reflected in the individual inverse Mills ratios.

²⁵ These or similar problems of applications of the Heckman procedure are often noted in applied work. A case in point is Spatz (2004).

unsatisfactory in terms of explaining the variation in earnings. These results are mainly owed to a combination of the following two factors. First, lower levels of education are highly significant in selecting an individual into agriculture. Second, there is little variation in these variables for those in non-agricultural sectors. In light of these theoretical and practical arguments we used OLS rather than Heckman correction procedures.

3.2.2 *Estimation results*

With few exceptions the explanatory variables of the mover-stayer models as well as in the wage/profit equations are significant at the 5 percent level.²⁶ The detailed regression results are reported in the Appendices 7.1 and 7.2, but here we just want to comment on some results that we find remarkable and consider of particular importance with regard to the simulation exercise.

The mover-stayer models appear to have some predictive power for the decision to move out of agriculture, as indicated for example the Pseudo R^2 of 0.07 for the heads' and 0.15 for the non-heads' mover-stayer model. It should be noted that measures of fit for logit models can only provide a rough indication of whether a model is adequate (Long and Freese 2001).

In the mover-stayer model for heads, one educational dummy for 10 or more years of schooling, turned out to have a significant positive influence on moving out of agriculture. Yet, we find a number of factors that negatively affect the choice of moving, among which age is the most important one. As we would expect, older individuals are less likely to move out of agriculture. The effect of a discrete change in age of some years is particularly strong for younger individuals. Working only for own-consumption also has quite a strong negative effect on the propensity to move out of agriculture. Many of these own-consumption workers are employed in the livestock sector and possibly even own livestock. In addition, if household heads own land or if they have an agreement with the landowner to occupy the land, they are more likely to stay in agriculture. Owning land or other agricultural production factors, such as livestock, hence acts as important barrier to intersectoral movements. Finally, household heads from the north are more likely to move out of agriculture, an interesting finding one might not necessarily expect, as the north is a region with a low share in agricultural employment.

As described above, the list of explanatory variables for non-heads is longer. The strongest determinant of moving out of agriculture is the dummy indicating whether the

²⁶ Standard errors are adjusted for clustering.

household head is employed in a non-agricultural sector. We can think of either a self-employed head being able to offer employment to other household members in a non-agricultural household enterprise or networks of a wage-employed head that facilitate finding non-agricultural employment for relatives. In addition, the choice of the household head to leave agriculture strongly influences the choice of the non-heads. Educational dummies for having finished primary and secondary education have a significant positive effect on the probability of moving out of agriculture. This effect is strongest for having finished primary education and declines somewhat for higher educational levels. The effect of a change in experience is much stronger than the effect of the corresponding change in the squared term. As in the case of the heads, the overall marginal effect of experience (including the squared term) declines with increasing experience. The subset of coefficients for educational dummies, experience, and squared experience can be interpreted as reflecting the earnings opportunities of an individual in non-agricultural employment. In other words, these five explanatory variables can be thought of as a reduced form representation of the wage differential between agricultural and non-agricultural activities. Accordingly, the coefficients for education can be seen to reflect decreasing returns to education for the movers and the results for experience appear to catch both the effect of age being a barrier to move out of agriculture as well as the typical seniority effect in earnings, i.e. increasing but marginally decreasing returns to experience. In a similar way, the significant and negative coefficients for racial dummies can be interpreted either or both as a direct barrier to non-agricultural employment and/or an argument in a reduced form wage differential model. The finding that racial dummies were not found to be significant for the heads suggests that they are significant for the non-heads due to their role in determining wages.

Non-remunerated workers are less likely to move out of agriculture. This finding points towards the importance of externalities associated to this type of employment, as estimation results indicate that the income gains due to an additional household member engaged in the household farm are rather moderate (see Appendix 7.2). The coefficients of being an own-consumption worker or owning land are of the same sign as in the case of the heads and the changes in predicted probabilities due to a change in the dummy of equal magnitude.

In sum, the results for the heads show the barriers to moving out of agriculture, whereas the results for non-heads also illustrate the possible gains of such a move. Household heads appear to respond to wage differentials between agricultural and non-agricultural sectors to a lesser degree. They hence tend to be “trapped” in agricultural activities,

possibly due to factor market imperfections. Their decision to stay or move however is of great importance for the decision of other household members.

3.2.3 Simulation

The microsimulation involves three steps. First, households are reweighted in order to reflect the change in the skilled/unskilled labor ratio that results from different growth rates of these two types of labor over time. In a second step, unskilled labor moves out of agriculture until the new share of unskilled labor in agriculture given by the CGE is reproduced. Third, wages/profits are adjusted according to the CGE results taking into account the changes in the skill composition of the workforce as well as the sectoral movements of unskilled labor from agriculture into non-agricultural sectors.

The reweighting procedure basically increases the weight of skilled individuals and decreases the weight of unskilled individuals to reach a new given ratio of unskilled to skilled workers following an efficient information processing rule.²⁷ Let *weight* denote the old weight (normalized to 1), and *nweight* the new weight of individual *i*. As Robilliard and Robinson (2001), we estimate the new weights by minimizing the Kullback-Leibler cross-entropy measure of the distance between the new and the old weights

$$\text{Min } \sum_i nweight_i \cdot \ln \left(\frac{nweight_i}{weight_i} \right) \quad (32)$$

subject to the following constraints

$$\frac{\sum_i nweight_i \cdot u_i}{\sum_i nweight_i \cdot s_i} = \frac{lu \cdot (1 + g_u)}{ls \cdot (1 + g_s)} = \frac{lu^*}{ls^*} \quad (33)$$

$$\sum_i nweight_i = 1 \quad (34)$$

²⁷ For details on maximum entropy econometrics see Golan, Judge and Miller (1996). Robilliard and Robinson (2001) apply these methods to reweight household survey weights. They also provide a GAMS code for solving this type of problems.

with $u(s)$, a dummy variable for unskilled (skilled) individuals i , $lu(ls)$, the initial unskilled (skilled) labor force, and $g_u(g_s)$, the cumulative growth rate (between 2001 and 2015) of the unskilled (skilled) labor force. $lu^*(ls^*)$ hence denotes the target value for the number of unskilled (skilled) labor. Equation (33) hence states that the new weights have to reflect the new skill composition (the ratio of unskilled to skilled workers) of the workforce. Equation (34) is the adding-up normalization constraint.

Note that this procedure gives new individual weights for just the employed population. Yet, for our purposes we need household weights for entire population. So we averaged over the new weights in those households where one or more individuals were employed. Households without any employed members were assigned the old weight. Note that the resulting unskilled-skilled ratio under these “final” new weights is of course not exactly equal to the ratio imposed in the cross-entropy reweighting.²⁸ Since the workforce in agriculture is almost entirely unskilled (more than 95 percent), the share of the unskilled labor force in agriculture is only slightly lower under the new weights. We use these new weights throughout the following parts of the microsimulation.

The estimation of the sectoral choice logit model and the two wage equations provide the basis for the following steps in the simulation. In the second step, we apply the changes in the sectoral composition of the workforce from the CGE (from agricultural into non-agricultural sectors) to the microlevel. In the simulation, those individuals from agriculture with the highest propensity to move to non-agricultural sectors are chosen to leave agriculture. This propensity is simulated by calculating the linear prediction of the logit model and adding a simulated residual.

Equations (35) to (39) indicate how we move unskilled individuals out of agriculture. Let the index j refer to all unskilled individuals employed in the agricultural sector and i to all employed individuals. Note that the share of unskilled agricultural employment may change (and actually does, but only slightly) because of the introduction of the new weights at this stage and that $move$ (not $move^*$) is 0 for all j , as their observed choice is to stay in agriculture. Individuals move to non-agricultural sectors, i.e. $move^*$ equals 1, if the utility associated to the choice to move increases. Equations (38) and (39) illustrate that we increase the utility of moving by augmenting the constants $\hat{\alpha}_{msh}$ and $\hat{\alpha}_{msnh}$ by $\Delta\alpha_{msh}$ and $\Delta\alpha_{msnh}$, respectively, in order to make individuals move. Changes in the choices of the heads have an impact on the choices of the non-heads, as the head's choice enters the utility of the non-heads, indicated by X_{msnh}^* . The residuals $\hat{\varepsilon}_{msh}^1$ and $\hat{\varepsilon}_{msnh}^1$ are

²⁸ We acknowledge that this is an ad-hoc procedure. In principle, it is possible to reweight all individuals respecting all necessary constraints. Yet, we consider the value added of this computationally quite expensive exercise too low.

simulated such that the resulting utility is consistent with the observed outcome in the initial situation.²⁹ Using a Newton-Raphson algorithm, we augment the constants until equation (35) holds.

$$\tilde{agrshare} = \frac{\sum_j nweight_j - \sum_j move_j^* \cdot nweight_j}{\sum_i nweight_i} \quad (35)$$

with

$$move^* = 1 \text{ if } U^*(move^*=1) > U^*(move^*=0) \quad (36)$$

$$move^* = 0 \text{ otherwise} \quad (37)$$

and

$$U^*(move^* = 1)_{msh} = (\hat{\alpha}_{msh} + \Delta\alpha_{msh}) + X_{msh} \hat{\beta}_{msh} + \hat{\varepsilon}_{msh}^1 \quad (38)$$

$$U^*(move^* = 1)_{msnh} = (\hat{\alpha}_{msnh} + \Delta\alpha_{msnh}) + X_{msnh}^* \hat{\beta}_{msnh} + \hat{\varepsilon}_{msnh}^1 \quad (39)$$

In order to determine both $\Delta\alpha_{msh}$ and $\Delta\alpha_{msnh}$ we need another equation. We decided to fix the share of heads and non-heads movers so that equation (40) holds.

$$\frac{\sum_j move_j^{msh} \cdot weight_j}{\sum_j move_j^{msnh} \cdot weight_j} = \frac{\sum_j move_j^{*msh} \cdot nweight_j}{\sum_j move_j^{*msnh} \cdot nweight_j} \quad (40)$$

After the assigning new weights and moving individuals out of agriculture, wages/profits need to be adjusted according to the CGE results in the third step of the simulation. We illustrate the procedure of adjusting the constants of the wage/profit equations for unskilled labor only.³⁰ Let $k=1, \dots, K$ be an index for unskilled individuals still employed in agriculture (excluding non-remunerated household members), $k=K+1, \dots, M$ for the movers, and, finally, $k=M+1, \dots, L$ for those unskilled in non-agricultural sectors who have been employed there before (again excluding non-remunerated household

²⁹ There are also residuals associated to $move = 0$, which is why the residuals of $move = 1$ have the superscript 1.

³⁰ For skilled labor, the adjustment in the constant only needs to account for the changes in weights.

members). We assume that non-remunerated household members earn an own labor income once they move out of agriculture. In equations (42) and (44) we calculate the target values for average labor income in agricultural and non-agricultural sectors, $\tilde{w}_{uagr}$ and $\tilde{w}_{unagr}$, respectively, simply by multiplying initial average labor income by the growth rates g_{uagr} and g_{unagr} given by the CGE. These target values for the new distribution are reached by adjusting the constants in the wage/profit equations, as indicated by equations (43) and (45), taking into account the new weights that reflect the changed skill composition of the labor force. Note that for agriculture the procedure is slightly more complicated, as we also have to take into account that the dummy for agricultural self-employment as well as the number of non-remunerated family members might change, indicated by X_{uagr}^* in equation (43).

$$\tilde{w}_{uagr} = \frac{\sum_{k=1}^M w_{uagr_k} \cdot weight_k}{\sum_{k=1}^M weight_k} \cdot (1 + g_{uagr}) \quad (42)$$

$$\begin{aligned} \tilde{w}_{uagr} &= \frac{\sum_{k=1}^K w_{uagr_k}^* \cdot nweight_k}{\sum_{k=1}^K nweight_k} \\ &= \frac{\sum_{k=1}^K \exp\left((\alpha_{uagr} + \Delta\alpha_{uagr}) + X_{uagr}^* \hat{\beta}_{uagr} + \hat{u}w_{uagr}\right)_k \cdot nweight_k}{\sum_{k=1}^K nweight_k} \end{aligned} \quad (43)$$

$$\tilde{w}_{unagr} = \frac{\sum_{l=M+1}^L w_{unagr_l} \cdot weight_l}{\sum_{l=M+1}^L weight_l} \cdot (1 + g_{unagr}) \quad (44)$$

$$\begin{aligned}
\tilde{w}_{unagr} &= \frac{\sum_{l=K+1}^L w_{unagr_l}^* \cdot nweight_l}{\sum_{l=K+1}^L nweight_l} \\
&= \frac{\sum_{l=K+1}^L \exp\left((\alpha_{unagr} + \Delta\alpha_{unagr}) + X_{unagr} \hat{\beta}_{unagr} + \hat{u}w_{unagr}\right)_l \cdot nweight_l}{\sum_{l=K+1}^L nweight_l}
\end{aligned} \tag{45}$$

The unexplained wage $\hat{u}w_{unagr}$ for those who enter non-agriculture is calculated by taking the unexplained wage from agriculture and multiplying it by the ratio of the standard deviations of the residuals in the non-agricultural and agricultural sectors, respectively. For non-remunerated household members moving into non-agricultural sectors we simulate a residual.

In addition to labor income, we consider transfer and capital income as reported in the PNAD. Transfer income is scaled up or down with the GDP per capita growth rate and capital income with the change in the rental rate from the CGE model. The sum of all household members' individual incomes is divided by the number of household members to give the income per capita. We use regional poverty lines taking a R\$ 80 per capita poverty line (in current 2001 prices) for urban Rio de Janeiro as a basis and adjusting for regional price differences following Paes de Barros (2004). The poverty lines are reported in appendix 7.4.

3.2.4 Shortcomings

Before we proceed to the results of our analysis, some shortcomings of the present approach have to be noted that will be addressed in future work. First, the household income generation process is of course much more complex than the proposed microsimulation model suggests. Many structural features of the Brazilian labor market, such as a high degree of informality in wage-employment and the important role of self-employment, are only accounted for rudimentarily. The major reason is that there is no point in modeling these labor market features on the micro level if they are not reflected in the CGE. Second, the data that we use to estimate the mover-stayer model may not only capture long-term transitions from agricultural into non-agricultural employment. Some of the movers may actually move into a non-agricultural job only temporarily, for example due to seasonal reasons. Third, doubts have emerged regarding the reliability of

the information drawn from the PNAD, in particular on rural, informal sector, and capital income (World Bank 2003).

Finally, it may seem natural to assume that the sectoral movements are somehow related to physical migration from rural to urban areas either within or even between the Brazilian regions.³¹ Traditionally, migration has acted as an important adjustment mechanism in Brazil. Nearly 40 percent of all Brazilians have migrated at one point in their lives (Fiess and Verner 2003). However, the data does not allow to link intersectoral movements to geographical migration. First, the migration-related questions of the PNAD unfortunately do not cover rural-urban migration. The available information is on whether an individual has moved between municipalities and/or between federal states. Second, using the information on migration in combination with the employment history from the PNAD 2001 suggests that only a minor share of about 12 percent of those leaving the agriculture actually migrates to another municipality. Approximately half of these migrants move to another federal state. In light of the importance of migration as an adjustment mechanism and the fact that the decline in agricultural employment is accompanied by a reduction in the rural population of equal magnitude, we think that these figures reflect data deficiencies rather than the Brazilian reality. It is quite likely that migrants are underrepresented in the PNAD. Therefore, we had to ignore the issue of geographical migration here due to the low share of migrants among the sectoral movers. Exploring these issues further and extending the model by linking structural change to geographical migration could prove a fruitful exercise, particularly in the Brazilian context.

4 Brazil in the Next Decade: How Trade Policy Affects a Business as Usual Scenario?

A central question of this paper is assessing the poverty effects of trade policy reforms in the long run, when many structural adjustment forces shape the income generation process. Our starting point consists of using our CGE model to build a business as usual scenario depicting the evolution of the Brazilian economy in the next decade. This evolution should not be considered as a statistical forecast, but rather as a consistent “projection” of the economy in a future where inter-sectoral productivity growth differentials, skill upgrading, and migration of labor out of farming activities play major

³¹ This would of course add to the list of arguments why the labor market for the unskilled should be considered segmented.

roles. This Business as Usual (BaU) projection is then contrasted with alternative scenarios where trade policy reforms are added. The following subsections, describe in details the macro and micro results for the BaU and trade scenarios.

4.1 The Business as Usual Macro Results

In the BaU scenario, real GDP for Brazil is projected to grow (from 2005 onwards) at the fairly sustained yearly rate of 3.3%; this is somewhat optimistic when compared with the recent two decades' (1980-2000) rate of 2%. This GDP growth performance is backed up by strong factor productivity growth rates. As explained above, productivity in the agriculture sector is factor neutral and its growth rate is exogenously set at 2.9% per year; in the non-farm sectors, growth of labor productivity is calibrated at 1.02% per year and growth of capital productivity at 0.82% per year.

These differences in productivity growth rates across sectors, combined with faster growth of the supply of skilled versus unskilled labor generate significant structural adjustments, in line with those observed for the last decade. The changes in the structure of labor markets, shown in Table 2, are of particular relevance for poverty and income distribution trends. On the supply side, education increases the supply of skilled workers which is growing at a 2.0% annual rate versus a yearly 1.6% growth rate for the unskilled labor supply. Additionally, through out-migration, the supply of unskilled workers in agriculture is shrinking. Labor demand is affected by the following three factors: labor productivity in agriculture is exogenous and slightly higher than in the rest of the economy; income elasticity of private consumption is below one for agricultural commodities and above one for other commodities; and, finally, international prices for traded agricultural products are decreasing through time. These three factors concur in reducing demand for labor in agricultural sectors and are the key drivers for the migration towards the non-agricultural segment.

The described supply and demand trends are equilibrated by movements in the wages. In the time horizon considered here, the education premium is declining: real wages of the skilled increase at 1.3% annually. In non-agricultural sectors, wages for unskilled workers increase by the yearly rate of 0.9%, however this upward trend is dumped by migration. The reverse happens to agricultural wages which are boosted by the implied reduction of supply due to out-migration.

Table 2: Medium term labor market structural adjustments, 2001-2015

	Productivity of L	Income Elast of Demand	Employment		Wages		Unskilled Lab Migration as % of:		Cumulative Migration
			Skilled	Unskilled	Skilled	Unskilled	Sending Pop	Receiving Pop	
	Yearly gr	constant	Yearly growth rates				Yearly %		Millions
Agri	2.9	0.54		0.0		1.7	1.7		-4.0
Non-Agri	1.0	1.05		2.2		0.9		0.5	4.0
Economywide			2.0	1.7	1.3				

Source: Authors' calculations

As shown in Table 3 these structural trends result in a significant 5 percent points shrinking in the agricultural employment for unskilled combined with a reduction of the unskilled wage gap between agriculture and non-agriculture. Notice that the employment percent structure of this table is one of the key variables linking the macro and micro models.

Table 3: Employment shares and wage ratios in 2001 and 2015

	Employment %				Unskilled Wages	
	2001	2015	2001	2015	2001	2015
	Skilled		Unskilled			
Agri	4	3	27	22		
Non-Agri	96	97	73	78		
Ratio N-Agri/Agri					1.8	1.6

Source: Authors' calculations

The BaU's GDP and labor markets macro trends are linked to developments at the sectoral level (shown in Table 4). Output growth rates are slightly lower for the agricultural sectors than for the non-agricultural ones. Agriculture exports, due to falling primary commodity international prices, grow at a slightly lower pace than non-agriculture exports. Additionally, in agricultural sectors, employment of unskilled workers is stalled or reduced, whereas demand for skilled workers, whose wages are increasing at a contained pace, is increasing. Productivity gains dictate that less workers are needed to achieve the same output, and rising wages, in particular for unskilled workers, induce producers to substitute (although with a low level of substitution) skilled workers for unskilled ones. The rightmost panel of the table shows the relative sizes of sectors in terms of employment and the skill intensities of each sector. Services are the largest employers of both skilled and unskilled workers but, on average, they use skilled labor more intensively. Agriculture employs almost a third of unskilled workers and uses this factor quite intensively, whereas manufacturing labor intensities are in-between agriculture and services.

Table 4: BaU's output and trade sectoral growth rates, and employment intensities

	Annual average growth rates					Employment percentages			
	Output	Imports	Exports	Labor Demand		by sector		by skill	
				Skilled	Unsk.	Skilled	Unsk.	Skilled	Unsk.
CerealGrains	3.2	2.5	2.3	0.3	0.1	0	5	2	98
OilSeeds	3.1	2.2	2.4	0.1	-0.1	0	1	6	94
RawSugar	3.2			0.2	0.1	0	1	4	96
OtherCrops	2.9	1.3	2.5	0.0	-0.1	1	12	3	97
Livestock	3.2	1.5		0.3	0.1	2	4	10	90
RawAnimalProducts	3.3	2.5	1.6	0.4	0.3	0	3	1	99
OilMinerals	3.3	3.0	2.9	1.5	1.7	0	0	15	85
LightManufacturing	3.3	0.8	3.7	1.0	1.2	1	2	16	84
AgriIndustriesExp	3.2	0.5	3.4	1.0	1.2	2	3	16	84
WoodProductsPaper	3.3	0.9	3.5	1.0	1.2	2	2	15	85
ChemicalsOilPr	3.3	1.8	2.9	1.1	1.3	2	1	30	70
MetalMineralProducts	3.5	1.8	3.3	1.2	1.4	2	2	17	83
MachineryEquipment	3.6	1.9	3.5	1.4	1.6	3	2	28	72
OtherServices	3.0	2.6	1.7	2.1	2.3	58	30	33	67
Construction	3.2			2.3	2.5	2	8	6	94
TradeCommunication	3.1	2.4	1.8	2.2	2.4	15	18	17	83
PublicServices	3.1	2.7	1.7	2.2	2.4	9	4	41	59
Agri	3.0	1.9	2.4		0.0	4	27	6	96
Non-Agri	3.2	2.0	3.1		2.2	96	73	29	76
Economywide	3.2	2.0	3.1	2.0		100	100	28	76

Source: Authors' calculations. Note: the mapping of this table sectors and GTAP sectors is shown in appendix 7.5, see Table 24 and Table 25.

4.2 Distributional and Poverty Results for the BaU

A moderate decrease in poverty between 2001 and 2015 results from micro-simulating the identified key structural trends on the Brazilian household data. Considering the full sample of all households, the headcount poverty ratio (P0) declines by about 6 percentage points (see Table 5). The reduction of the average normalized poverty gap (P1) and the poverty severity index (P2) indicates that those who remain poor move closer to the poverty line.³² Inequality changes very little, as indicated by the 0.1 decrease in Gini coefficient (or as in the Theil or other inequality indices, not reported).

These average indices indicate that some progress in reducing aggregate poverty and inequality is achieved in a Business as Usual scenario, but these aggregate measures may conceal relevant distributional changes at a more disaggregated level. In fact, reaching stronger poverty reduction may require specific pro-poor policies which often rely, for

³² A short note on the interpretation of the reported poverty measures: The income-gap ratio, i.e. average income shortfall (of the poor) divided by the poverty line, can be calculated as P1/P0. This ratio is 0.4 for all households in our case, i.e. the perfectly targeted cash transfer needed to lift every poor person out of poverty is 40 percent of the poverty line times the number of the poor. Thus, 0.4 times the percentage point change in P0 (here 2.4) provides a percentage point change benchmark for evaluating the change in P1, as this would be the change in P1 that we would observe had the average income of the poor stayed constant while the headcount declined.

their successful implementation, on more detailed information about disaggregated distributional effects.

A first obvious way to gather more detailed information is to analyze the poverty and inequality impacts separately for the agricultural and non-agricultural households.

Table 5: Poverty and inequality in the BaU scenario, by sectors

	All households		Non-agricultural households		Agricultural households	
	2001 level	2001-15 change	2001 level	2001-15 change	2001 level	2001-15 change
PC income	314.9	1.5	351.9	1.2	148.3	2.3
Gini	58.6	-0.1	57.1	0.6	56.6	-0.7
P0	23.6	-5.6	18.6	-3.1	46.2	-13.8
P1	9.6	-3.0	7.1	-1.6	21.0	-8.0
P2	5.3	-1.8	3.7	-0.9	12.3	-5.2
Population %	100		81.8	3.3	18.2	-3.3
Contr. to P0			64.4	8.8	35.6	-8.8

Source: Authors' calculations. Note: PC income is per capita income in 2001 R\$ and the change is given as annual growth rate. All levels are in percent and changes in percentage points.

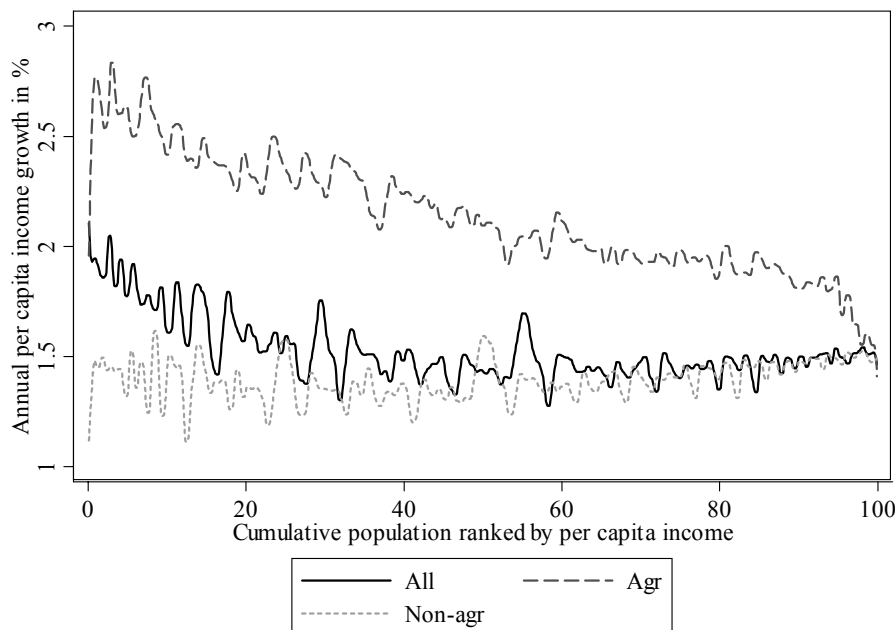
A household is classified as “agricultural” when its head and/or at least two of its members are employed in agriculture. In 2001, according to this classification, agricultural households accounted for 18.2 percent of the Brazilian population, poverty incidence among them almost reached 50 percent, and their contribution to total poverty was about 36 percent (see Table 5). Between 2001 and 2015, the share of agricultural households in the population shrinks by 3.3 percentage points following the decline in agricultural employment of more than 5 percentage points. Poverty among agricultural households falls by more than 13 percentage points, whereas poverty among non-agricultural households decreases by only 3.1 percent. Accordingly, the contribution of agricultural households to the headcount falls by almost 9 percentage points.

A more detailed analysis also shows that the lack of progress in aggregate inequality is due to the agricultural and non-agricultural groups' individual inequality indicators moving in opposite directions. Among non-agricultural households, inequality rises because skilled labor income, a major source of income for these households, grows faster than that of unskilled labor. Conversely, inequality among agricultural households falls, mainly because richer agricultural households earn a higher share of their income from non-agricultural unskilled labor and, in some cases, from skilled labor.

Another way of analyzing detailed distributional effects is to consider growth incidence curves. These curves plot per capita income growth at income percentiles (Ravallion and Chen 2003) and are shown in Figure 1 for all households as well as for the agricultural

and non-agricultural groups.³³ Reflecting the increase in unskilled agricultural wages from the CGE model's results, per capita income growth is much higher for agricultural households. In addition, the agricultural growth incidence curve illustrates a strong pro-poor distributional shift, which reflects both the increase in agricultural labor incomes and the gains resulting from moving out of agriculture. These agricultural households specific distribution shifts also explain the pro-poor changes in the national distribution, since only minor distributional changes are registered in the non-agricultural distribution. However, richer non-agricultural households experience somewhat higher gains than poorer households. Non-agricultural poor household incomes increase by a meager 1 to 1.5 percent annually.

Figure 1: Growth incidence curves, BaU, all, agricultural, and non-agricultural households



Source: Authors' calculations.

These more detailed analyses of the long term evolution of the Brazilian income distribution highlight the different roles played by changes in inequality and shifts in the growth rates of the average incomes. The following two relevant questions then arise: if the current (2001) distribution of income were to remain unchanged, how would additional growth help in reducing poverty? And, what is the role of the differential in the sectoral growth rates for agriculture and non-agriculture in reducing poverty?

³³ The household category, i.e. agricultural or non-agricultural household, is the category the household belonged to in the base year 2001.

Answering these questions requires performing two additional micro-simulations as follows. The first simulation generates a counterfactual distribution under the assumption that all incomes out of all sources grow by 1.5 percent annually. This implies shifting the entire income distribution “to the right” leaving its shape unchanged. Individuals do not change employment sectors and hence households retain their initial non-agricultural or agricultural classification. Results are presented in Table 6 and changes are given as percentage share of the BaU change (column I). In addition, we simulated a second counterfactual distribution for agricultural and non-agricultural households separately with per capita incomes of the respective household types growing with the BaU rates, i.e. by 1.3 percent annually for non-agricultural and 2.4 percent annually for the agricultural households (column II).

Table 6: Poverty and inequality in a distributionally neutral scenario

	All households			Non-agricultural households			Agricultural households		
	2001 level	% of BaU change I	% of BaU change II	2001 level	% of BaU change I	% of BaU change II	2001 level	% of BaU change I	% of BaU change II
PC income	314.9	100.0	100.0	351.9	117.7	98.6	148.3	65.7	102.9
P0	23.6	91.7	102.4	18.6	139.8	133.3	45.9	56.5	90.5
P1	9.6	90.9	97.7	7.1	132.5	119.7	20.8	61.9	93.2
P2	5.3	86.8	97.9	3.7	125.6	114.3	12.1	62.6	93.4

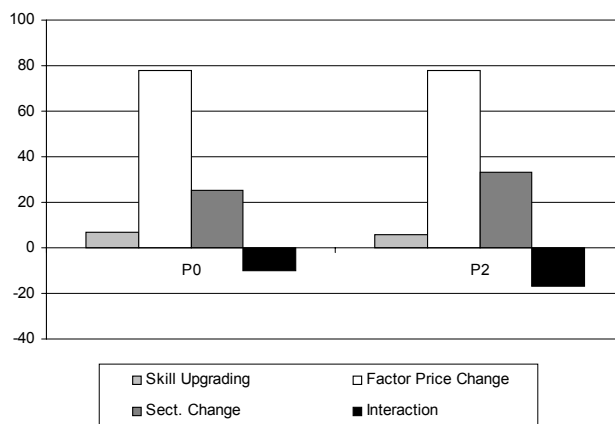
Source: Authors' calculations.

The comparison of the counterfactual simulations of the “completely” distributionally neutral (column I) and the “separately” neutral (column II) scenarios shows that the growth bias in favor of agricultural households is poverty reducing. Yet, the difference between the BaU and the completely neutral scenario does not seem too pronounced. This is due to the fact that poverty among non-agricultural households is reduced much more than in the BaU, where the income distribution among these households worsens. This “slight” worsening of the income distribution hence hampers quite strongly the potential of growth to reduce poverty among non-agricultural households. In addition, the differences between the two neutral scenarios for non-agricultural households illustrate that a 0.2 percentage point difference in annual growth rates for 14 years can make a difference in terms of poverty reduction. The last two columns of Table 6 show the importance of growth for reducing poverty among agricultural households as well. A 0.9 point percentage point difference in annual income growth rates for 14 years implies a reduction of about 5 percentage points less in the headcount over this time period. In contrast to what we see for non-agricultural households, the impact of the pro-poor distributional shift for agricultural households observed in the BaU is relatively small. In

other words, had the income distribution among agricultural households not improved, growth would have reduced poverty by only little less.

The poverty reductions recorded in the BaU scenario are due the change in skill endowments, the increase in real factor prices, and inter-sectoral movements. A main advantage of micro-simulation techniques is their ability to decompose the total effect in different partial effects that can be attributed to single causes. A slight complication arises because different causes interact. The interaction arises because factor incomes increase at different rates in agricultural and non-agricultural sectors. By simulating counterfactual distributions, where only one cause at the time, or a combination of two of them, are included, it is possible to decompose the total effect into individual or joint (interactive) contributions.

Figure 2: Decomposition of poverty changes, BaU, all households



Source: Authors' calculations. Note: The figure displays the contribution of the respective component to the total change in P0 and P2, respectively, in percent. The contributions add to 100. Contributions refer to reductions in the respective poverty indices.

Figure 2 displays the results of this decomposition. Factor price changes account for the largest share of total poverty reduction. The change in the skill composition of the workforce does not contribute much to poverty reduction, whereas the sectoral shifts are quite important, in particular for the poorer among the poor, as the higher contribution of the sectoral change component with regard to P2 indicates. This implies that households with members moving out of the agricultural sector escape poverty. We consider this issue in more detail later. The interaction component, which actually is a sum of distinct interaction components, hampers poverty reduction. Counterfactual simulations show that the interaction between sectoral movements and income changes is the most important

one. It is negative since people move out of agriculture where their incomes would have increased much more than in non-agricultural sectors.

In sum, the distributional and poverty analysis suggests that the BaU scenario leads to relatively little poverty reduction. Agricultural households fare quite well and the poverty incidence and intensity among them is reduced quite substantially. Decomposition analyses show that sectoral change contributes quite significantly to poverty reduction, although income growth is the most important source of poverty reduction. Micro-accounting exercises underline the importance of growth for poverty reduction, but we also illustrate that slight increases in inequality can considerably reduce the poverty reduction potential of growth in the context of a high-inequality country, such as Brazil.

4.3 Macro results for the full liberalization and the Doha trade policy shocks

The trade shocks simulated in the dynamic CGE model consist of changes in Brazilian tariff protection against imports from the rest of the world and of exogenous changes of international prices of traded goods and export quantities demanded by foreigners.³⁴ The shocks are assumed to take place progressively through a gradual phasing-in starting in 2005 and lasting 6 years. Table 7 displays these shocks as percentage changes of the final year (2015) between the BaU and the trade reform scenarios. As part of the shock and to leave the government fiscal balance unchanged, tariff revenue losses are compensated by a lump sum transfer implemented as an increase in the direct taxes paid by households. This lump sum additional tax is the least distortionary instrument that can be readily used in our model, however, in practice, the Brazilian government may chose other forms of compensatory taxes which may alter relative prices and have significant income distribution effects.

³⁴ It should be noted that to mimic the global model results for increased demand for Brazilian exports and changes in international prices, we introduce a downward sloping export demand function as shown in equation (1) above. During a shock, for obvious reasons, we cannot target both prices and quantities and the shock is implemented by modifying both the international price index *WPEindex* (the price shock) and the intercept α_k^e (the quantity shock). Our Brazil (single-country) model will then endogenously determine the quantity supplied.

Table 7: Trade shock – Tariff reductions and international prices changes

	Own Tariff reductions			Change in import prices			Change in export prices		
	Full	Deep	Weak	Full	Deep	Weak	Full	Deep	Weak
	Liber.	Doha	Doha	Liber.	Doha	Doha	Liber.	Doha	Doha
CerealGrains	-100			8	2.0	2.1	16	5.9	6.0
OilSeeds	-100			6	2.5	2.5	14	4.8	4.9
RawSugar				2	0.9	1.0	14	5.3	5.4
OtherCrops	-100	0	0	2	0.9	0.9	13	4.7	4.8
Livestock	-100			2	1.0	1.1	25	9.7	9.8
RawAnimalProducts	-100			2	0.4	0.4	18	6.6	6.7
OilMinerals	-100	0		0	0.1	0.1	2	1.1	1.3
LightManufacturing	-100	-6	0	1	1.1	1.2	9	3.8	4.0
AgriIndustriesExp	-100	-4	-1	0	0.6	0.6	7	3.0	3.2
WoodProductsPaper	-100	-6	-2	0	0.0	0.0	4	1.8	2.0
ChemicalsOilPr	-100	-11	-3	-1	-0.1	0.0	3	1.4	1.7
MetalMineralProducts	-100	-6	-1	0	0.0	0.0	3	1.6	1.7
MachineryEquipment	-100	-7	-2	0	0.0	0.0	2	1.5	1.7
OtherServices				0	0.0	0.0	5	2.0	2.2
Construction				0	0.0	0.0	4	1.7	1.9
TradeCommunication				0	-0.1	-0.1	5	1.9	2.1
PublicServices				0	-0.1	-0.1	5	2.1	2.3
Agri	-100	0	0	5	1.5	1.5	14	4.8	4.9
Non-Agri	-100	-7	-2	0	0.0	0.1	4	1.9	2.1
Economywide	-100	-7	-2	0	0.1	0.1	5	2.2	2.4

Source: Authors' calculations.

The full liberalization scenario has the largest impacts: tariffs are completely eliminated and Brazil enjoys strong terms of trade gains; the other two shocks, representing two possible versions of the Doha negotiation outcomes, generate almost no own liberalization and fairly muted global prices effects. In order to fully appreciate their final effects, these shocks need to be mapped to the economic structure of Brazil. Table 8 presents this structure and helps in this regard. For instance, in the full liberalization scenario, export oriented sectors – those displaying high shares of export to domestic output – such as Oilseeds, Other Crops and the industrial sectors transforming agricultural products (*AgriIndustriesExp* which buys most of its inputs from agriculture) record considerable increases of their export prices. Conversely, import competing sectors, such as Chemicals and Oil derived products and capital goods, do not face high increases in their international prices. These combined export and import price movements result in fairly strong terms of trade gains, inducing significant reallocation of resources towards export oriented sectors. Additional push for this reallocation comes from Brazil's own liberalization which entails a reduction of the anti-export bias implicit in the higher protection rates for manufacturing of the initial tariff structure.

Table 8: Initial (year 2001) structure of the Brazilian economy

	tariff rates	Sectoral Imports	Imports / DomDemand of Composite	Sectoral Output	Sectoral Exports	Exports / Dom Output
CerealGrains	7	1	15	1	0	1
OilSeeds	6	0	8	0	4	29
RawSugar	0	0	0	0	0	0
OtherCrops	9	2	3	4	8	7
Livestock	3	0	1	1	0	0
RawAnimalProducts	8	0	1	1	0	1
OilMinerals	4	7	33	1	7	25
LightManufacturing	17	4	5	5	3	2
AgriIndustriesExp	18	3	3	7	19	11
WoodProductsPaper	9	2	5	3	7	10
ChemicalsOilPr	9	15	10	9	8	3
MetalMineralProducts	12	5	6	5	13	11
MachineryEquipment	19	37	27	8	20	11
OtherServices	0	11	3	23	5	1
Construction	0	0	0	8	0	0
TradeCommunication	0	10	5	13	5	2
PublicServices	0	2	1	11	1	0
Agri	8	4	4	7	12	6
Nagri	11	96	6	93	88	4
Economywide	11	100	6	100	100	4

Source: Authors' calculations.

These effects are detailed in Table 9. The complete elimination of tariffs in the full liberalization case explains the large increase of imports (measured in volume) which, in the final year of this scenario, is 21% above the value in the same year of the BaU. Increases in imports of agricultural goods are much weaker: an aggregate 6% increase versus the 21% surge of the non-agriculture bundle. The combination of lower initial tariffs and stronger international price increases for agriculture, with respect to non-agriculture, explain the difference in import response of these two aggregate sectors. Given their very limited scope of tariff reduction, the Doha scenarios imply much more contained changes of imports.

With high elasticity of substitution in demand (currently set at 4), cheaper imports have the potential to displace domestic production, especially for those goods whose demand is fulfilled by a large share of foreign supply. For Brazil, this is the case for the Chemicals, and Capital goods sectors. In the full liberalization scenario, domestic production experiences significant market share losses in these sectors; however this is not happening in the Doha cases. The competition from cheaper imports is also reflected – again only for the full liberalization case – in the decline of prices of domestic output.

Table 9: Brazil' structural adjustment, per cent changes in the final year between BaU and trade shocks

	Demand side									Supply side								
	Import Volumes			Domestic Demand of dom products			Price of domestic output in dom mkts			Export Volumes			Domestic Output			Price of domestic output		
	Full	Deep	Weak	Full	Deep	Weak	Full	Deep	Weak	Full	Deep	Weak	Full	Deep	Weak	Full	Deep	Weak
	Liber.	Doha	Doha	Liber.	Doha	Doha	Liber.	Doha	Doha	Liber.	Doha	Doha	Liber.	Doha	Doha	Liber.	Doha	Doha
CerealGrains	-6	-3	-3	4	1	1	-2	1	1	68	14	13	5	1	1	-2	1	1
OilSeeds	-18	-8	-7	5	1	1	-6	0	0	60	9	8	20	3	3	-3	1	1
RawSugar				0	0	0	-2	1	1				0	0	0	-2	1	1
OtherCrops	23	1	2	1	0	0	-1	1	1	6	-3	-3	1	0	0	-1	1	1
Livestock	-4	1	1	3	1	1	-2	1	1				3	1	1	-2	1	1
RawAnimalProducts	22	4	5	2	1	1	-2	1	1	5	0	-1	2	1	1	-2	1	1
OilMinerals	-6	0	1	1	-1	-1	-5	0	1	26	2	1	7	0	0	-4	0	1
LightManufacturing	48	0	-3	0	1	1	-5	0	0	159	62	61	5	3	3	-4	0	1
AgriIndustriesExp	59	2	1	0	0	0	-4	0	1	30	4	4	3	1	1	-4	1	1
WoodProductsPaper	23	4	4	-1	0	0	-4	0	1	11	-1	-1	0	0	0	-4	0	1
ChemicalsOilPr	18	5	3	-2	-1	0	-4	0	1	9	-1	-1	-2	-1	0	-4	0	1
MetalMineralProducts	24	3	2	-4	-1	-1	-5	0	1	15	0	-1	-2	-1	-1	-4	0	1
MachineryEquipment	42	5	3	-12	-2	-1	-6	0	1	11	-1	-2	-10	-1	-1	-5	0	1
OtherServices				1	0	0	-4	0	1				1	0	0	-4	0	1
Construction	-14	2	3	0	0	0	-3	0	1	8	-1	-1	0	0	0	-3	0	1
TradeCommunication	-12	2	3	0	0	0	-3	0	1	6	-1	-2	0	0	0	-3	0	1
PublicServices	-13	2	3	0	0	0	-3	0	1	7	-1	-2	0	0	0	-3	0	1
Agri	6	-2	-1	2	1	1	-2	1	1	22	1	0	3	1	1	-2	1	1
Non-Agri	21	3	3	-1	0	0	-4	0	1	21	3	2	0	0	0	-4	0	1
Economywide	21	3	3	-1	0	0	-4	0	1	21	3	2	0	0	0	-4	0	1

Source: Authors' calculations.

These demand/imports side effects are linked to the supply response to which we now turn. For producers of exportable goods, the reduction of prices in local markets (ΔP_d) combined with unchanged or rising export prices creates incentives to increase the share of sales destined to foreign markets. This export response (shown in the columns "Export Volumes") varies across sectors and it is linked to the pattern of Brazil's comparative advantage and to the increase in international prices. Brazil's comparative advantage can be ascertained by considering the export orientation (Exports / Dom Output) column in Table 8, which highlights three sectors in particular: Oilseeds, Other Crops, and the Agricultural transformation industry. These sectors – which also enjoy large jumps in their international price – experience export surges. Due to the generally positive export price shocks, other sectors join in an overall expansion of supply to foreign markets. Rising export sales more than offset, or at least compensate, reductions of domestic sales and lead to changes observed in the columns labeled "Domestic Output". Finally output price changes (in the rightmost columns) are in between those of domestic prices and those of export prices for the simple reason that output prices are a combination (CET prices) of (generally) rising export prices and domestic prices.

As for the demand side, similar across-scenarios differences are observed for the supply side. In particular, given the closure rule for the foreign market, economy wide increases of import volumes are balanced by a comparable increase in exports.³⁵

In summary, trade reforms promote a production structure specialized towards exportables, which in Brazil is translated in a specialization towards primary or agricultural transformation sectors. This agriculture export-led boom is fully achieved only in the full liberalization scenario, given its stronger price changes and the elimination of tariffs.³⁶

The full liberalization and the two Doha scenarios entail trade policy reforms that combine, in different proportions, domestic tariff abatement with external price and quantity shocks. It has been shown that, in most situations, unilateral liberalization is beneficial; however it may be of interest, especially from a negotiation point of view, to decompose the total effect and ascertain the shares attributable to domestic liberalization and to external shocks. Given the interactions between Brazilian domestic policies and the Rest of the World (ROW) policies, a decomposition exercise is path dependent, therefore the shares attributed to one set of policy or the other will differ according to the choice in their sequencing.

³⁵ Due to the closure rule of the external account, namely the fixing of foreign savings, and the full employment assumption, the slightly lower expansion of the volumes of exports, with respect to import volumes is compensated with a real exchange rate appreciation which originates from rising domestic resource costs.

³⁶ It should be stressed that in our model trade opening only produces allocative efficiency gains and not other, potentially much stronger, dynamic productivity gains.

Table 10: Effects on imports, exports and real GDP due to combined or partial shock (Indices, BaU = 100 in 2015)

	Demand side			Supply side			"Welfare"		
	Import Volumes			Export Volumes			Real GDP		
	Full Liber.	Deep Doha	Weak Doha	Full Liber.	Deep Doha	Weak Doha	Full Liber.	Deep Doha	Weak Doha
Combined (Own + Rest of the World liberalization) shock --- BaU = 100									
Agri	105.7	98.3	99.1	122.4	100.7	100.2	102.9	100.0	99.9
Non-Agri	121.3	103.3	102.7	121.0	102.7	102.0	100.1	100.0	100.0
Economywide	120.8	103.1	102.5	121.2	102.5	101.8	100.2	100.0	100.0
Own shock --- BaU = 100									
Agri	107.3	98.9	99.8	114.5	100.8	100.2	102.0	100.2	100.0
Non-Agri	113.1	100.8	100.2	116.6	101.0	100.3	100.2	100.0	100.0
Economywide	112.9	100.8	100.2	116.4	101.0	100.3	100.3	100.0	100.0
Rest of the World shock --- BaU = 100									
Agri	96.8	99.4	99.4	107.1	99.9	99.9	101.0	99.8	99.8
Non-Agri	107.5	102.4	102.4	104.2	101.7	101.7	99.9	100.0	100.0
Economywide	107.1	102.3	102.3	104.4	101.5	101.6	100.0	100.0	100.0

Note: For each variable, these indices are calculated as the ratio of the level in the trade scenarios to that of the BaU scenario for the last year (2015) and multiplied by 100. Source: Authors' calculations.

For three key variables, Table 10 shows the effects of the total and partial shocks as indices calculated on the levels reached in the final year, with the final year for the BaU equal to 100. In the case of the full liberalization scenario and across all variables, own liberalization accounts for a large share of the total shock. Imports in agriculture actually increase more in the partial own liberalization shock than in the combined shock, given that the external shock drives international agricultural prices up. The reduction of the mentioned anti-(agriculture-)export bias implicit in the initial protection, is also explaining the large share of export and real GDP effects accounted by the own liberalization shock.

Decomposition results for the Doha scenarios are less clear cut. The magnitudes of the shocks are much smaller, however even the very low levels of domestic tariff abatement seem to matter for the final result. A relevant policy lesson emerges from the comparison of the two partial shocks panels of Table 10: a passive non reciprocating attitude may bring some advantages; however these are quite limited, even in the extreme case where every one in the world but Brazil implements full liberalization. In fact, these externally-induced benefits may be greatly enhanced by an active domestic liberalization reform.

For their poverty and income distribution implications, changes in factors' markets are the most important aspect of the structural adjustment caused by trade reform. Changes in wages and sectoral employment are linked to changes of goods prices through the production technology and the functioning of the factor markets. Different production technologies are approximated by different factor's intensities across sectors, as shown in Table 4, and labor markets function so as to mimic realistic adjustment possibilities:

skilled workers can freely move across all sectors, whereas unskilled ones face two segmented markets and can just imperfectly migrate from the agricultural to the non agricultural segment.

Table 11: Factor markets effects

	Employment		Wages		Unskilled Lab Migration as % of:		Cumulative Migration 2001-2015 Millions	Unskilled employment 2015 %
	Skilled	Un-skilled	Skilled	Un-skilled	Sending Pop	Receiv- ing Pop		
	Yearly growth rates				Yearly %			
Business as Usual:								
Agri		0.02		1.68	1.66		-4.04	21.51
Non-Agri		2.20		0.91	0.53		4.04	78.49
Economywide	2.0	1.7	1.26					
Full Liberalization:								
Agri		0.18		2.10	1.51		-3.71	21.99
Non-Agri		2.15		1.07	0.49		3.71	78.01
Economywide	2.0	1.7	1.32					
Deep Doha:								
Agri		0.06		1.78	1.62		-3.96	21.64
Non-Agri		2.19		0.93	0.52		3.96	78.36
Economywide	2.0	1.7	1.27					
Weak Doha:								
Agri		0.06		1.77	1.62		-3.96	21.63
Non-Agri		2.19		0.93	0.52		3.96	78.37
Economywide	2.0	1.7	1.26					

Source: Authors' calculations.

Table 11 highlights how trade shocks affect labor market structural adjustments. Due to its agriculture boom and its increased demand for “agricultural” factors of production, the full trade liberalization induces a significant increase in the wage rate for unskilled workers. When compared with the BaU, the yearly rate of growth of wage of unskilled workers in agriculture is 0.4 percentage points higher, and this higher rate accounts for a cumulative 14 year growth of 34% much higher than the cumulative growth of 26% in the BaU. Given this wage incentive, migration decreases and about 340 thousands workers who were moving out of agriculture in the BaU scenario do not switch activity in the full liberalization case. This has some effect on the aggregate distribution of unskilled workers between agriculture and non-agriculture, as shown in the last column of Table 11.

As far as the Doha scenarios are concerned, negligible effects are recorded for the employment structure and some weak wage increase is observed for unskilled in agriculture.

4.4 Trade Scenarios' Distributional and Poverty Results

Two fundamental results emerge from analyzing the micro impacts of the trade scenarios. Firstly, our initial hypothesis that trade liberalization, by working against the “natural” forces of structural change, might weaken long term trends of poverty reduction has been discarded. Although less people migrate towards higher paid non-agricultural jobs, mainly through increased agricultural incomes, poverty is further reduced in the trade liberalization scenarios. However, and this is the second fundamental result, trade reform as envisaged in the current Doha scenarios – but even in the hypothetical full liberalization one – is not of great help in the fight against poverty and its complete eradication needs additional more targeted and possibly more costly interventions.

These two sets of results are clearly illustrated by Table 12, which shows the poverty and distributional outcomes as percentage point differences between the trade scenarios and the BaU scenario for the final (2015) year: the full liberalization scenario leads to a further reduction in the headcount poverty index of 0.5 percentage points, whereas for deep Doha scenario the effects are almost negligible.³⁷ Similarly the Gini index is reduced by 0.2 and 0.1 percentage points in the full liberalization and deep Doha scenarios.

Table 12: Poverty and Distributional Impact of Trade, all households

	BaU 2015	% point diff. Doha	% point diff. Full
Gini	58.5	-0.1	-0.2
P0	18.0	-0.2	-0.5
P1	6.6	-0.1	-0.2
P2	3.5	0.0	-0.1

Source: Authors' calculations.

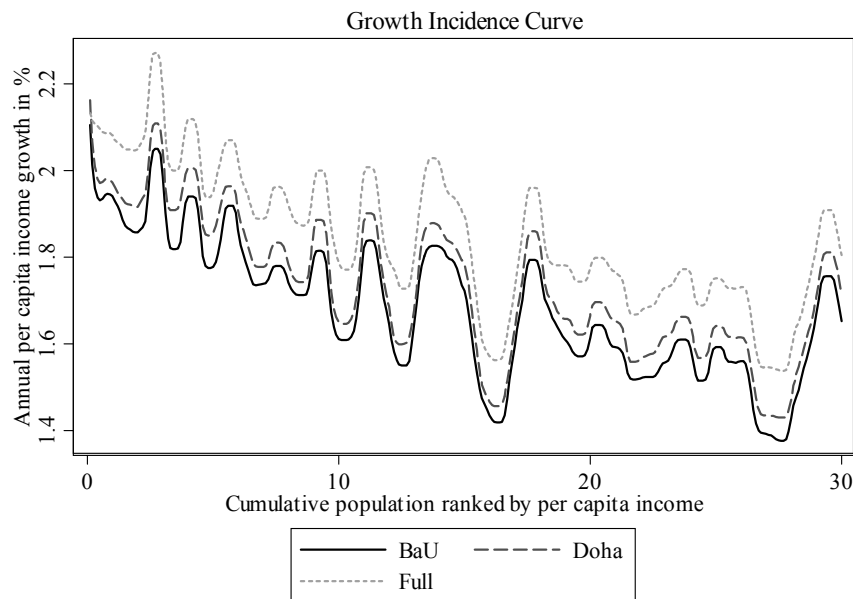
As for the BaU scenario, a thorough assessment of the trade scenarios needs to go beyond these aggregate indicators and should rely on more disaggregate poverty and distributional analyses. In search of trade-induced poverty effects, the remaining part of this section considers an array of indicators, from growth incidence curves to poverty statistics estimated on specific sub samples. In particular poverty and distributional impacts are separately measured for the agricultural and non-agricultural groups, the movers and stayers, the rural and urban populations, the regional samples, and the

³⁷ Given that the weak Doha scenario does not produce any visible results, in this section we just report results for the full liberalization and the deep Doha scenarios.

groupings obtained by educational attainment, by land ownership, and by occupational status.

Figure 3 shows the growth incidence curves for the poorest thirty percent of all households under the three scenarios. The curve for the deep Doha scenario lies slightly above the BaU curve. The full liberalization reform also shifts the whole curve upwards, however this shift is larger than that of the Doha case, and it seems to favor the poorest among the poor; in other words, full liberalization appears to induce an additional pro-poor distributional shift.

Figure 3: Growth incidence curves for the BaU and Trade scenarios, poorest 30 percent of all households



Source: Authors' calculations.

Table 13 shows the sectorally disaggregated results. Inequality for all households falls due to decreased inequality among agricultural households and lower inequality increase among non-agricultural households, although inequality between these two groups may have risen somewhat. Despite declining inequality and slightly higher per capita income growth, poverty reduction for agricultural households barely changes and this is due, as shown below, by the lower migration levels induced by the trade shocks. Indeed, in the deep Doha scenario the reduction in the population share of agricultural households is only very slightly below that achieved in the BaU. More remarkable is the additional poverty reduction for non-agricultural households that can largely be explained by the lower increase in inequality, as per capita income growth is only marginally higher.

Table 13: Poverty and inequality in the Doha scenario, by sector

	All households			Non-agricultural households			Agricultural households		
	2001 levels	2001-15 changes	% of BaU change	2001 levels	2001-15 changes	% of BaU change	2001 levels	2001-15 changes	% of BaU change
PC income	314.9	1.5	101.5	351.9	1.3	102.1	148.3	2.4	101.3
Gini	58.6	-0.2	194.4	57.1	0.5	81.8	56.6	-0.8	111.5
P0	23.6	-5.8	103.4	18.6	-3.3	106.5	46.2	-14.0	101.5
P1	9.6	-3.1	102.7	7.1	-1.6	104.6	21.0	-8.2	102.1
P2	5.3	-1.9	102.5	3.7	-0.9	104.3	12.3	-5.3	102.0
Population %	100.0			81.8	3.2	98.3	18.2	-3.2	98.3
Contr. to P0				64.4	8.6	96.0	35.6	-8.6	96.0

Source: Authors' calculations.

Given its larger price and quantities shocks, the full liberalization scenario yields more significant poverty changes, as shown in Table 14. In contrast to the Doha scenario, agricultural households gain considerably from full liberalization and their headcount index is reduced by almost 1.5 percentage points. This sector specific income gains more than compensate the further (albeit small) reduction of agricultural out-migration.

For non-agricultural households, the full liberalization scenario improves the income distribution, the Gini increases by only 72 per cent of the increase recorded in the BaU. Growth is only slightly higher for this group of households but, as shown above, minor distributional shifts accompanied by slightly higher growth can result in significant poverty reduction.

Table 14: Poverty and inequality in the Full scenario, by sector

	All households			Non-agricultural households			Agricultural households		
	2001 levels	2001-15 changes	% of BaU change	2001 levels	2001-15 changes	% of BaU change	2001 levels	2001-15 changes	% of BaU change
PC income	314.9	1.6	106.4	351.9	1.3	106.8	148.3	2.6	109.8
Gini	58.6	-0.3	312.2	57.1	0.5	72.0	56.6	-0.9	117.0
P0	23.6	-6.1	109.2	18.6	-3.6	116.3	46.2	-14.9	108.0
P1	9.6	-3.2	108.2	7.1	-1.8	113.7	21.0	-8.6	107.4
P2	5.3	-1.9	107.8	3.7	-1.0	113.0	12.3	-5.6	107.2
Population %	100.0			81.8	3.1	93.0	18.2	-3.1	93.0
Contr. to P0				64.4	8.4	96.0	35.6	-7.6	96.0

Source: Authors' calculations.

Trade shocks simultaneously increase agricultural incomes and reduce inter-sectoral migration and how these two contrasting forces affect poverty outcome depends on the income levels (and therefore on the socio-economic characteristics) of those who decide to stay instead of moving. The next set of tables sheds some light on this issue.

Table 15 shows the poverty levels and changes under the BaU and the trade scenarios for agricultural households who *remained* in agriculture. First consider the BaU case. Having identified those households that will not move, it is possible to calculate the headcount

for this group in the initial year (2001): their headcount is equal to 44.1% more than 2 percentage points below the 46.2 level³⁸ calculated for all 2001 (stayer and potential mover) agricultural households. This lower *level* of poverty implies that moving households are on average poorer than those who remain in agriculture. Accordingly, the *changes* in P0 are 12.1 instead of 13.7 percentage points. In 2015, about 15 percent of the population still live in agricultural households.³⁹ The agricultural expansion following trade liberalization has only a minor effect on agricultural employment, by far not enough to offset the reduction in agricultural employment from the BaU. Accordingly, the change of the share of agricultural households due to trade liberalization is only minor, in particular for the Doha scenario. Yet, when translated in actual migrating individuals, this small share change means that almost four hundred thousand individuals – who would have become members of non-agricultural households in the BaU – in the full liberalization scenario remain in agricultural households. Despite the fact that these “potential mover households” are on average poorer than the typical “stayer household”, as we illustrate below, poverty among agricultural households decreases compared to the BaU. The poor stayers hence gain under both trade scenarios although this gain is almost negligible for the Doha scenario.

Table 15: Poverty impact of trade, agri stayers

	2001 levels	Households remaining in agri BaU 2001-15 changes	Doha % of BaU change	Full % of BaU change
P0	44.1	-11.7	101.7	109.5
P1	20.0	-7.0	102.4	108.5
P2	11.7	-4.6	102.3	108.2
Population %		14.9	100.4	101.5

Source: Authors' calculations.

As could be indirectly inferred from the analysis of the stayers, the group of the movers should experience the largest welfare gains. Indeed as illustrated in Table 16, in the BaU agricultural households who become non-agricultural households record a 22.4 percentage points reduction in their headcount index, down from a considerably high, especially in comparison to the stayers group, initial level of 56.6 percent.

³⁸ Shown in Table 5.

³⁹ The initial poverty levels among those who stay in agriculture under the trade scenarios are almost identical to the initial levels among the BaU stayers, so we decided not to report them. The same holds for the movers, for whom we report results later.

This outcome could not be derived straightforwardly from the estimation of the migration choice. In fact, the estimations showed that potential migrants were found to be poorer, in particular landless, heads, but also better educated, hence less poor, non-heads. The explicit quantitative measurements allowed by micro-simulation were needed to highlight the poverty reducing role of changes in the sectoral composition of employment.

The observed poverty reduction under the trade scenarios is of a moderate additional increase. This is due to the income increases trade reforms induce in the non-agriculture sectors, but also because the fewer households that still move out of agriculture under the trade scenarios are actually poorer.

Table 16: Poverty impact of trade, sectoral movers

	Agri households who have become non-agri			
	2001 levels	BaU 2001-15 changes	Doha % of BaU change	Full % of BaU change
P0	56.6	-22.4	105.1	108.2
P1	26.0	-14.0	102.0	105.4
P2	15.2	-9.4	101.7	105.1
Population %		3.1	98.0	92.5

Source: Authors' calculations.

One final category needs to be examined: the non-agricultural stayers. Representing 80 percent of the population, this is a large group; however, given the negligible migration out of the non-agricultural sector observed in the data, this group is explicitly excluded from the migration choice. For these households, the full liberalization brings about an additional reduction in the headcount of 0.4 percentage points, and through its favorable impact on non-agricultural unskilled wages the Doha scenario, too, makes a small but noticeable difference.

Table 17: Poverty impact of trade, non-agri stayers

	Non-agri households before and after			
	2001 levels	BaU 2001-15 changes	Doha % of BaU change	Full % of BaU change
P0	18.6	-3.8	104.0	110.7
P1	7.1	-1.8	103.3	109.8
P2	3.7	-1.0	103.2	109.5
Population %	82.4			

Source: Authors' calculations.

Up to this point, the disaggregated analysis of the poverty impacts has been based on sectoral affiliation and thus it has been possible to link it directly to the sectoral results generated by the CGE model. However, additional policy relevant criteria can be used to identify other groups of households and to evaluate their specific trade induced poverty effects. In particular, we conduct impact analyses for rural and urban areas, by regions, by land ownership, by educational level and by occupation. Obviously, all these criteria are somehow correlated to basic categories included in the CGE model, for example the educational level is linked to the skilled/unskilled factor types, or the region to the prevalence of agricultural employment, but strict correlation should not limit the micro analysis. Using the full household survey information provides maximum flexibility and allows extracting ex-post additional information. Instead of roughly inferring the poverty impact on certain groups from correlations between the rigidly CGE embedded categories and micro characteristics, the generated counterfactual income distributions contain all the information needed and hence directly provide a quantitative assessment of the poverty impact on specific groups.

Table 18: Poverty and inequality impact of trade, urban and rural

	Urban				Rural			
	2001 levels	BaU 2001-15 changes	Doha % of BaU change	Full % of BaU change	2001 levels	BaU 2001-15 changes	Doha % of BaU change	Full % of BaU change
P0	19.6	-4.0	103.8	112.2	44.4	-12.1	103.1	108.2
P1	7.6	-2.0	103.2	110.1	20.1	-7.1	102.5	108.2
P2	4.0	-1.2	103.0	109.5	11.7	-4.7	102.3	107.7
Population %	83.7	1.3	99.5	93.2	16.3	-1.3	99.5	93.2
Contr. to P0	69.4	3.9	96.6	35.5	30.6	-3.7	102.3	119.8

Source: Authors' calculations.

Table 18 shows the poverty impact of trade by urban or rural residence. Interestingly, the share of urban households in 2001 (83.7 percent) is even higher, although not much, than the share of non-agricultural households (81.8 percent). Quite some households live in urban areas, very likely in urban peripheries, and earn their living primarily from agricultural wage-employment. Actually, only 66 percent of the agricultural households live in rural areas, while 5 percent of the non-agricultural households live in rural areas. The micro-simulations that generate the results of Table 18 also take into account rural-urban migration by assuming that households migrate to urban areas if *all* employed household members leave agriculture. In the BaU, this causes the rural population to decline by 1.3 percentage points. The urban population accounts for almost 70 percent of the Brazilian poor in 2001 and this share rises in the BaU by 3.9 percentage points. Urban poverty declines under both trade scenarios with the decline being stronger under the full

liberalization scenario. The Doha scenario hardly affects rural poverty, but full liberalization decreases the rural headcount by an additional percentage point. Some simple calculations can give some more meaning to these figures: The 0.5 percentage point difference in P0 in the full liberalization scenario means that approx. 135 000 people are lifted out of poverty. The 1 percentage point difference implied by the full liberalization scenario reduces the number of poor people in rural areas by approx. 115 000. Considering the very small increase in non-agricultural unskilled wages this may be somewhat surprising, but it is the urban concentration that drives this result. Some more growth in urban areas lifts more people out of poverty than very high agricultural growth.

Table 19: Poverty impact of trade, by region

Region	2001 initial levels			2015		
	Population %	P0	% contr. to P0	BaU 2001-15 P0 change	Doha % of BaU P0 change	Full % of BaU P0 change
North	5.7	34.0	8.2	-7.9	101.0	107.7
Northeast	28.5	45.4	54.8	-9.3	102.6	109.5
Southeast	43.5	12.4	22.8	-3.7	101.9	107.9
South	15.2	14.7	9.5	-4.6	101.4	107.8
Center-West	7.1	16.0	4.8	-5.0	119.4	121.3

Source: Authors' calculations.

Due to the regional differences both in factor endowments and specialization patterns, we might expect poverty reduction patterns to differ substantially between the regions for the BaU as well as for the trade shocks. The reduction in the headcount for the BaU confirms this expectation, as poverty declines more strongly in the Northeast, South, and Center-West, the regions with the highest shares in agricultural employment. The Doha round has negligible effects across all regions although the figures in Table 19 suggest a different story for the Center-West. Yet, a look at the changes of P1 and P2 (not reported) demonstrates that this strong effect is due to many households being just below the poverty line in this region.⁴⁰ The Northeast, the region with the highest incidence of poverty where more than 50 percent of the Brazilian poor reside, benefits most from the Doha liberalization and about 50 000 individuals are lifted out of poverty in this region. In the same region, full liberalization helps about 175 000 individuals to escape poverty. The poor in the North, another region with worryingly high poverty rates, gain relatively little from trade liberalization, whereas poverty in the South as well as in the Center-West

⁴⁰ This is a case that illustrates why we usually report not only the headcount index, as this indicator can be quite misleading in some instances.

decreases quite substantially due to the importance of agricultural income for the poor in these regions.

Table 20: Poverty impact of trade, agricultural stayers by owning land

	Landowner households				No land owning households			
	2001 levels	BaU 2001-15 changes	Doha % of BaU change	Full % of BaU change	2001 levels	BaU 2001-15 changes	Doha % of BaU change	Full % of BaU change
P0	37.1	-10.5	101.7	108.0	48.5	-12.5	101.9	110.6
P1	16.6	-6.2	102.7	109.1	22.2	-7.4	102.3	108.4
P2	9.5	-3.9	102.7	109.4	13.1	-5.0	102.2	107.8
Population %	38.4				61.6			

Source: Authors' calculations.

Table 20 shows the poverty changes for landowners and agricultural households who do not own land separately. The landowning households account for approximately 40 percent of the population in agricultural households. The differences between the two groups of agricultural households are quite striking. The poverty incidence among landowning households is much lower; the difference is more than 10 percentage points. Poverty decreases quite substantially for both groups in the BaU. Note that we only consider households who stay in agriculture. Poor households who do not own land benefit little from the Doha round, but full liberalization brings about an additional decrease of more than 1 percentage point in the headcount (affecting almost 100 000 individuals). The reason why they benefit more from both trade scenarios is that they are more specialized in agricultural income. This is not necessarily what one would expect, but it may well be that owning land provides the resources to set up a small non-agricultural business. Noteworthy is the finding that under both trade scenarios poverty gap as well as severity index decrease stronger than the headcount in terms of the BaU change. This again has to do with the specialization of households. The poorer landowning households derive a higher share of their income from agriculture whereas the richer households (at least among the poor) earn a higher share of income from non-agricultural activities.

Table 21: Poverty impact of trade, by educational levels

Hh. average schooling	2001 initial levels			2015			
	Population %	P0	% contr. to P0	Population %	BaU 2001-15 P0 change	Doha % of BaU P0 change	Full % of BaU P0 change
<= 3	16.2	52.3	35.9	16.0	-10.7	103.5	111.5
<=5	16.9	36.0	25.7	16.6	-9.1	102.9	109.9
<=8	20.9	21.1	18.7	20.7	-5.6	105.0	111.5
<=10	12.9	11.3	6.2	12.9	-2.9	104.6	111.3
>=11	33.1	9.6	13.5	33.7	-2.0	101.7	104.6

Source: Authors' calculations.

As Table 21 indicates, the educational level of the households is an important determinant of poverty. The headcount among households with 3 or less average years of schooling of the employed household members is well above 50 percent. This group accounts for 16.2 percent of the population but for more than a third of the poor. The poverty incidence among households with 4 or 5 years of schooling is 15 percentage points lower. For both groups with ten or more years of average schooling, the headcount is about 10 percent. The Doha round does not appear to be particularly helpful for those with little educational endowment. Yet, the full liberalization scenario again leads to a substantial additional reduction in poverty.

Finally, we analyze the poverty impact of trade reform by occupational groups. In Table 22 we differentiate between wage-employed, self-employed and households with members engaged in both types of employment in agricultural and non-agricultural activities, respectively.⁴¹ In addition, there are households with no employed household member. One out of five poor people in Brazil comes from a self-employed agricultural household, and the agricultural wage-employed households are almost equally poor. In non-agricultural households, the difference between self-employed and wage-employed households in terms of poverty is not too pronounced. Due to their high share in the population, non-agricultural wage-employed households account for more than a third of the Brazilian poor. Poverty rates are significantly lower for households who derive their income from both wage-and self-employment. Under the Doha scenario, all non-agricultural household groups gain, whereas there are only minor gains for agricultural households. As noted above, full liberalization however helps both agricultural and non-agricultural households. Interestingly, poverty in non-agricultural activities declines more

⁴¹ If the number of self-employed household members is greater than the number of wage-employed members, the household is considered self-employed, and vice versa. Are the numbers equal, the households falls under the "both" category.

among the self-employed, whereas in agricultural activities the decline is stronger for the wage-employed. As in the case of households who do not own land, the agricultural wage-employed households derive more income from agricultural unskilled labor than agricultural self-employed households. For non-agricultural households, it is the greater importance of skilled income for the wage-employed that makes poverty decline less strongly for this group.

Table 22: Poverty impact of trade, by occupation

	2001 initial levels			BaU 2001-15		Doha 2001-15		Full 2001-15	
	Population %	P0	% contr. to P0	Population % change	P0 change	Population % change	% of BaU P0 change	Population % change	% of BaU P0 change
Agri wage-empl.	5.6	46.2	11.0	-1.5	-14.3	-1.5	101.5	-1.4	111.2
Agri self-empl.	10.2	48.0	20.7	-1.3	-13.7	-1.3	101.4	-1.2	106.7
Agri both	2.4	38.8	3.9	-0.5	-14.1	-0.5	101.3	-0.5	105.5
Not empl.	7.8	27.4	9.1	0.0	-4.3	0.0	100.0	0.0	100.0
Non-agri wage	48.5	17.2	35.3	1.6	-3.1	1.6	107.2	1.5	117.4
Non-agri self	15.9	22.7	15.3	1.1	-2.9	1.1	107.9	1.1	121.0
Non-agri both	9.6	11.5	4.7	0.6	-2.3	0.6	108.0	0.5	123.4

Source: Authors' calculations.

To sum up, the poverty changes under the deep Doha scenario are rather moderate and disappointing. With one exception, our analyses do not detect a particularly favorable effect on any of the poor and vulnerable groups that we have identified. This one exception is that the Doha scenario very slightly appears to favor the Northeast. Overall, income growth under the Doha scenario favors non-agricultural activities and, accordingly, urban areas. Since the population is concentrated in urban areas, some growth can already reduce poverty considerably, in particular if accompanied by a pro-poor distributional shift, as in the Doha scenario. Our analyses show that anti-poor changes in the distribution can easily dwarf the poverty reducing potential of growth. The income growth pattern under full liberalization tends to favor poor groups. Poor agricultural and less educated households benefit considerably more from full liberalization than from the Doha liberalizations.

5 Conclusions

Our analysis suggests that the economic effects of the Doha round, even of an “optimistic deep” liberalization scenario, are rather limited for Brazil. Accordingly, poverty would remain largely unaffected by this trade reform, which does not appear to be biased in favor any of particularly poor groups. Yet, through a slight improvement in the urban income distribution the Doha scenario has some positive effect on poverty.

In contrast, a full liberalization scenario implies quite substantial welfare gains that are concentrated among some of the poorest groups of the country, in particular those in agriculture. Consequently, the rural poor and certain comparably poor regions in Brazil benefit more than proportionately. This result is driven by an export boom in agriculture and agricultural processing industries, growing labor demand and associated higher wages. Following full liberalization, a smaller number of workers remain in agriculture compared to the BaU. Given that inter sectoral migration may substantially improve the income situation of a household, one may expect full liberalization to weaken poverty reduction. This expectation is supported by the observation that moving households are on average poorer than those remaining in agriculture. However, this is not the case, as the gain in agricultural incomes overcompensates the reduced benefits from lower migration flows.

The beneficial impact of the full liberalization is not limited to rural areas and agricultural activities. The urban poor benefit through higher incomes for unskilled labor also in non-agricultural sectors, which induces a pro-poor shift in the urban income distribution. In addition, the urban poor benefit indirectly from the gains in agriculture, as the pressure on non-agricultural unskilled is relieved somewhat. Trade reform, and in particular domestic trade reforms, may particularly help the Brazilian poor farmers, but only broad-based high growth will eradicate urban poverty.

Whether trade can do the job of significantly raising the incomes of the urban poor is questionable. In this regard an important limitation of our analysis is that we do not assume any dynamic gains from trade liberalization. Our results might hence be taken as a lower bound of the welfare effects, as there is strong evidence of a beneficial impact of trade liberalization on productivity (Winters, McCulloch, and McKay 2004). We also acknowledge that our representation of urban labor markets may be too simple to evaluate the precise effects on some particularly poor groups in urban areas, e.g. in informal activities.

The trade policy implications for Brazil are clear-cut. As Brazil does not lose from the possible Doha scenarios and even slightly gains, there is no reason to oppose such an outcome of the negotiations. Furthermore, our analysis suggests that Brazil and especially the Brazilian poor can substantially gain from own liberalization. An obvious complementary policy to a trade policy that favors the agricultural sector is to enable poor households to participate in agricultural growth. In the Brazilian context, an important means to do so is to provide access to land.

6 Bibliography

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7 Appendices

7.1 Estimation results, mover-stayer model

Mover-stayer model for heads, Logit estimates

Number of obs = 14365
Wald chi2(6) = 197.120
Prob > chi2 = 0.000
Pseudo R2 = 0.068
Log pseudo-likelihood = -1495.442

	Coef.	Robust Std. Err.	z	P> z	[95% Conf. Interval]	
dedu	0.419	0.278	1.510	0.132	-0.126	0.963
age	-0.044	0.005	-9.490	0.000	-0.053	-0.035
ddworkown	-1.123	0.319	-3.520	0.000	-1.749	-0.497
dcess	-0.825	0.327	-2.530	0.012	-1.466	-0.185
dprop	-0.736	0.172	-4.280	0.000	-1.074	-0.399
dgregio1	0.593	0.202	2.930	0.003	0.196	0.990
_cons	-1.708	0.178	-9.580	0.000	-2.058	-1.359

Changes in Predicted Probabilities for Moving out of Agriculture

	0->1	+-sd/2	MargEfct
dedu	0.008		0.007
age		-0.011	-0.001
ddworkown	-0.012		-0.018
dcess	-0.009		-0.013
dprop	-0.010		-0.012
dgregio1	0.012		0.009

Source: Authors' calculations. Note:

dedu: educational dummy for 10 or more years of schooling
ddworkown: dummy for own-consumption workers
dcess: holding ceded land
dprop: holding own land
dgregio1: north.

Mover-stayer model for non-heads, Logit estimates

Number of obs = 16737
Wald chi2(6) = 293.58
Prob > chi2 = 0.000
Pseudo R2 = 0.152
Log pseudo-likelihood = -1282.4805

	<i>Coef.</i>	<i>Robust Std. Err.</i>	<i>z</i>	<i>P> z </i>	<i>[95% Conf. Interval]</i>	
dprim3	0.782	0.229	3.410	0.001	0.332	1.232
dsec1	0.633	0.298	2.120	0.034	0.049	1.218
dsec2	0.597	0.324	1.840	0.066	-0.039	1.232
exp	0.101	0.023	4.340	0.000	0.055	0.146
exp2	-0.002	0.000	-4.270	0.000	-0.003	-0.001
gend	-0.759	0.188	-4.030	0.000	-1.127	-0.390
preta	-0.500	0.336	-1.490	0.137	-1.159	0.159
ddnonrem	-0.849	0.171	-4.960	0.000	-1.185	-0.513
ddworkown	-1.731	0.307	-5.640	0.000	-2.332	-1.130
dprop	-1.839	0.462	-3.980	0.000	-2.745	-0.934
headnagr	1.122	0.167	6.710	0.000	0.794	1.450
headmover	2.468	0.374	6.610	0.000	1.736	3.200
_cons	-4.369	0.298	-14.640	0.000	-4.954	-3.783

Changes in Predicted Probabilities for Moving out of Agriculture

	<i>0->1</i>	<i>-+sd/2</i>	<i>MargEfct</i>
dprim3	0.010		0.007
dsec1	0.007		0.006
dsec2	0.007		0.005
exp		0.017	0.001
exp2		-0.024	0.000
gend	-0.007		-0.007
preta	-0.004		-0.004
ddnonrem	-0.007		-0.007
ddworkown	-0.011		-0.015
dprop	-0.008		-0.016
headnagr	0.015		0.010
headmover	0.084		0.021

Source: Authors' calculations. Note:

dprim3: 9 years of schooling
dsec1: 11 or 11 years of schooling
dsec2: 12 years of schooling
exp: age minus schooling
exp2: experience squared
gend: female 1
preta: black
ddnonrem: non-remunerated household member
ddworkown: own-consumption worker
dprop: holding own land
headnagr: household head in non-agricultural sector
headmover: head has moved out of agriculture.

7.2 Estimation results, wage/profit equations

Wage/profit equation for agriculture unskilled

Number of obs = 22699
 F(11, 3209) = 419.53
 Prob > F = 0.000
 R-squared = 0.3021
 Root MSE = 0.83187

	Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]	
edu	0.084	0.003	27.270	0.000	0.078	0.090
exp	0.047	0.002	29.900	0.000	0.044	0.050
exp2	-0.001	0.000	-28.780	0.000	-0.001	-0.001
gend	-0.858	0.018	-46.640	0.000	-0.894	-0.822
preta	-0.138	0.027	-5.050	0.000	-0.191	-0.084
parda	-0.171	0.016	-10.490	0.000	-0.203	-0.139
nnonrem	0.043	0.009	4.790	0.000	0.025	0.060
drn	-0.129	0.049	-2.620	0.009	-0.225	-0.032
drne	-0.339	0.025	-13.590	0.000	-0.388	-0.290
drs	0.150	0.032	4.720	0.000	0.088	0.213
drcw	0.225	0.036	6.210	0.000	0.154	0.297
_cons	4.079	0.040	102.470	0.000	4.001	4.157

Source: Authors' calculations. Note:

edu: years of schooling
 exp: age minus schooling
 exp2: experience squared
 gend: female 1
 preta: black
 parda: mixed black
 nnonrem: number of non-remunerated household members
 d*: regional dummies with r for rural, n north, ne northeast, s south, cw center-west.

Wage/profit equation for non-agriculture unskilled

Number of obs = 96993
 F(16, 6514) = 1710.86
 Prob > F = 0.000
 R-squared = 0.423
 Root MSE = 0.67388

	<i>Robust Std.</i>					
	<i>Coef.</i>	<i>Err.</i>	<i>t</i>	<i>P> t </i>	<i>[95% Conf. Interval]</i>	
edu	0.008	0.003	2.840	0.004	0.003	0.014
edu2	0.006	0.000	33.350	0.000	0.006	0.007
exp	0.069	0.001	88.200	0.000	0.068	0.071
exp2	-0.001	0.000	-68.950	0.000	-0.001	-0.001
gend	-0.590	0.006	-102.830	0.000	-0.601	-0.579
preta	-0.148	0.011	-13.460	0.000	-0.169	-0.126
parda	-0.143	0.007	-21.910	0.000	-0.156	-0.130
dun	-0.190	0.013	-15.020	0.000	-0.214	-0.165
drn	-0.501	0.106	-4.710	0.000	-0.709	-0.293
dune	-0.450	0.011	-40.590	0.000	-0.472	-0.428
drne	-0.710	0.033	-21.800	0.000	-0.774	-0.646
drse	-0.229	0.029	-7.960	0.000	-0.286	-0.173
dus	-0.069	0.011	-6.470	0.000	-0.090	-0.048
drs	-0.171	0.029	-5.950	0.000	-0.227	-0.115
ducw	-0.123	0.013	-9.420	0.000	-0.149	-0.098
drcw	-0.383	0.054	-7.040	0.000	-0.490	-0.276
_cons	4.494	0.020	227.760	0.000	4.455	4.533

Source: Authors' calculations. Note:

edu: years of schooling
 edu2: edu squared
 exp: age minus schooling
 exp2: experience squared
 gend: female 1
 preta: black
 parda: mixed black
 nnonrem: number of non-remunerated household members
 d*: regional dummies with r (u) for rural (urban), n north, ne northeast, s south, cw center-west.

Wage/profit equation for skilled

Number of obs = 35696
 F(16, 6514) = 995.20
 Prob > F = 0.000
 R-squared = 0.453
 Root MSE = 0.749

	<i>Coef.</i>	<i>Robust Std. Err.</i>	<i>t</i>	<i>P> t </i>	<i>[95% Conf. Interval]</i>	
edu	-0.060	0.007	-9.140	0.000	-0.073	-0.047
edu2	0.009	0.000	30.520	0.000	0.009	0.010
exp	0.063	0.002	39.830	0.000	0.060	0.066
exp2	-0.001	0.000	-22.990	0.000	-0.001	-0.001
gend	-0.515	0.009	-55.410	0.000	-0.533	-0.497
preta	-0.277	0.024	-11.570	0.000	-0.324	-0.230
parda	-0.214	0.011	-18.600	0.000	-0.236	-0.191
dun	-0.153	0.023	-6.760	0.000	-0.198	-0.109
drn	-0.520	0.099	-5.260	0.000	-0.714	-0.326
dune	-0.408	0.018	-22.390	0.000	-0.443	-0.372
drne	-0.796	0.044	-18.130	0.000	-0.882	-0.710
drse	-0.276	0.055	-5.030	0.000	-0.384	-0.169
dus	-0.146	0.017	-8.600	0.000	-0.179	-0.113
drs	-0.317	0.052	-6.030	0.000	-0.419	-0.214
ducw	-0.122	0.023	-5.210	0.000	-0.168	-0.076
drcw	-0.108	0.098	-1.100	0.270	-0.301	0.084
_cons	5.278	0.043	122.680	0.000	5.194	5.363

Source: Authors' calculations. Note:

edu: years of schooling
 edu2: edu squared
 exp: age minus schooling
 exp2: experience squared
 gend: female 1
 preta: black
 parda: mixed black
 nnonrem: number of non-remunerated household members
 d*: regional dummies with r (u) for rural (urban), n north, ne northeast, s south, cw center-west.

7.3 Estimation results, labor market segmentation

Wage equation for testing segmentation hypothesis (unskilled)

Number of obs = 53279177
 F(47, 7228) = 1232.3
 Prob > F = 0
 R-squared = 0.5021
 Root MSE = 0.68619

	Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]	
dprim1	0.194	0.007	26.410	0.000	0.179	0.208
dprim2	0.343	0.008	41.420	0.000	0.327	0.359
dprim3	0.540	0.010	55.020	0.000	0.521	0.560
dsec1	0.637	0.012	53.890	0.000	0.613	0.660
dsec2	0.878	0.011	81.940	0.000	0.857	0.899
dter	1.464	0.019	78.220	0.000	1.428	1.501
exp	0.058	0.001	83.820	0.000	0.056	0.059
exp2	-0.001	0.000	-69.420	0.000	-0.001	-0.001
d1	-0.469	0.028	-16.510	0.000	-0.524	-0.413
d2	0.063	0.056	1.140	0.256	-0.046	0.172
d3	-0.011	0.024	-0.470	0.640	-0.059	0.036
d4	-0.238	0.017	-13.710	0.000	-0.272	-0.204
d5	-0.070	0.017	-4.030	0.000	-0.104	-0.036
d6	-0.722	0.028	-26.200	0.000	-0.776	-0.668
d7	0.226	0.049	4.610	0.000	0.130	0.322
d8	-0.033	0.012	-2.700	0.007	-0.058	-0.009
d9	0.024	0.016	1.530	0.126	-0.007	0.055
d10	0.020	0.023	0.890	0.374	-0.024	0.065
d11	0.124	0.019	6.520	0.000	0.087	0.162
d12	0.049	0.013	3.880	0.000	0.024	0.074
d13	0.135	0.015	9.230	0.000	0.106	0.164
d15	0.077	0.009	8.540	0.000	0.059	0.094
d16	0.093	0.007	13.020	0.000	0.079	0.107
d17	0.208	0.012	18.080	0.000	0.186	0.231
carteira	0.330	0.006	57.810	0.000	0.318	0.341
seasonal	-0.125	0.017	-7.260	0.000	-0.158	-0.091
dse	0.088	0.009	9.660	0.000	0.070	0.106
arrend	0.116	0.043	2.720	0.007	0.032	0.200
poss	-0.148	0.055	-2.720	0.007	-0.255	-0.041
cess	-0.278	0.041	-6.760	0.000	-0.359	-0.198
prop	0.077	0.023	3.350	0.001	0.032	0.122
dworkown	-0.138	0.021	-6.670	0.000	-0.179	-0.097
nnonrem	0.037	0.007	5.570	0.000	0.024	0.050
gend	-0.531	0.006	-89.070	0.000	-0.542	-0.519
preta	-0.144	0.010	-14.800	0.000	-0.163	-0.125
amarela	0.310	0.054	5.740	0.000	0.204	0.415
parda	-0.135	0.006	-22.770	0.000	-0.147	-0.124
dun	-0.144	0.012	-12.120	0.000	-0.167	-0.120
drn	-0.312	0.044	-7.010	0.000	-0.399	-0.225
dune	-0.422	0.010	-40.210	0.000	-0.443	-0.401
drne	-0.573	0.020	-29.350	0.000	-0.611	-0.534
drse	-0.223	0.021	-10.730	0.000	-0.264	-0.182
dus	-0.081	0.010	-7.960	0.000	-0.101	-0.061
drs	-0.142	0.024	-6.000	0.000	-0.188	-0.095
ducw	-0.081	0.013	-6.460	0.000	-0.105	-0.056
drcw	-0.141	0.026	-5.350	0.000	-0.193	-0.089
isourban2	-0.081	0.049	-1.660	0.098	-0.178	0.015
_cons	4.461	0.017	269.920	0.000	4.429	4.493

Wage equation for testing segmentation hypothesis (skilled)

Number of obs = 16669698
 F(47, 7228) = 357.69
 Prob > F = 0
 R-squared = 0.4503
 Root MSE = 0.75121

	Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]	
dprim1	0.200	0.040	5.050	0.000	0.122	0.277
dprim2	0.239	0.038	6.290	0.000	0.165	0.314
dprim3	0.425	0.037	11.490	0.000	0.352	0.497
dsec1	0.490	0.037	13.140	0.000	0.417	0.563
dsec2	0.766	0.035	22.190	0.000	0.698	0.834
dter	1.484	0.036	41.620	0.000	1.414	1.554
exp	0.067	0.002	43.160	0.000	0.064	0.070
exp2	-0.001	0.000	-26.140	0.000	-0.001	-0.001
d1	-0.417	0.152	-2.740	0.006	-0.714	-0.119
d2	0.499	0.176	2.840	0.005	0.154	0.843
d3	0.216	0.211	1.020	0.306	-0.198	0.630
d4	-0.319	0.065	-4.870	0.000	-0.447	-0.190
d5	0.035	0.052	0.690	0.493	-0.066	0.136
d6	-0.048	0.183	-0.260	0.792	-0.407	0.311
d7	0.345	0.073	4.720	0.000	0.202	0.489
d8	0.195	0.033	5.970	0.000	0.131	0.259
d9	0.133	0.037	3.630	0.000	0.061	0.205
d10	0.214	0.035	6.140	0.000	0.146	0.282
d11	0.280	0.036	7.670	0.000	0.208	0.351
d12	0.135	0.034	3.940	0.000	0.068	0.203
d13	0.066	0.034	1.980	0.048	0.001	0.132
d15	0.264	0.031	8.630	0.000	0.204	0.324
d16	0.185	0.015	12.670	0.000	0.157	0.214
d17	0.110	0.015	7.260	0.000	0.081	0.140
carteira	-0.059	0.012	-4.940	0.000	-0.083	-0.036
seasonal	-0.705	0.213	-3.320	0.001	-1.122	-0.289
dse	-0.254	0.025	-10.000	0.000	-0.304	-0.204
arrend	0.627	0.191	3.280	0.001	0.252	1.002
poss	-0.085	0.341	-0.250	0.802	-0.754	0.583
cess	-0.014	0.230	-0.060	0.952	-0.465	0.437
prop	0.391	0.062	6.350	0.000	0.270	0.512
nnonrem	0.039	0.017	2.340	0.019	0.006	0.072
gend	-0.473	0.009	-50.400	0.000	-0.492	-0.455
preta	-0.257	0.024	-10.910	0.000	-0.303	-0.211
amarela	0.255	0.069	3.680	0.000	0.120	0.391
parda	-0.209	0.011	-18.640	0.000	-0.231	-0.187
dun	-0.168	0.022	-7.470	0.000	-0.212	-0.124
drn	-0.635	0.102	-6.230	0.000	-0.835	-0.436
dune	-0.396	0.018	-21.520	0.000	-0.432	-0.360
drne	-0.784	0.040	-19.360	0.000	-0.863	-0.704
drse	-0.368	0.055	-6.730	0.000	-0.475	-0.261
dus	-0.161	0.017	-9.470	0.000	-0.194	-0.127
drs	-0.414	0.055	-7.580	0.000	-0.521	-0.307
ducw	-0.153	0.023	-6.510	0.000	-0.199	-0.107
drcw	-0.224	0.096	-2.330	0.020	-0.413	-0.035
isourban2	-0.028	0.078	-0.360	0.723	-0.180	0.125
_cons	5.007	0.040	123.880	0.000	4.928	5.086

Source: Authors' calculations. Note: The grey-shaded dummies are dummies for agricultural sectors.

7.4 Poverty lines, in 2001 R\$

Table 23: Regional poverty lines

North	Urban	87
	Rural	76
Northeast	Urban	85
	Rural	75
Center-West	Urban	70
	Rural	62
	Distrito Federal	82
Southeast	Urban Rio de Janeiro	80
	Rural Rio de Janeiro	72
	Urban Sao Paulo	84
	Rural Sao Paulo	69
	Urban Minas Gerais and Espirito Santo	66
	Rural Minas Gerais and Espirito Santo	57
South	Urban	83
	Rural	75

Source: Authors' calculations based on Paes de Barros (2004).

7.5 Macro model' Sectors

Table 24: Model-GTAP sector mapping

Model Sectors	GTAP 5 Sectors
1 CerealGrains	PDR WHT GRO
2 OilSeeds	OSD
3 RawSugar	C_B
4 OthCrops	V_F PFB OCR WOL FRS FSH
5 Livestock	CTL
6 RawAnimalProducts	OAP RMK
7 OilMinerals	COL OIL GAS OMN
8 LightManufacturing	CMT MIL PCR TEX WAP
9 AgriIndustriesExp	OMT VOL SGR OFD LEA B_T
10 WoodProductsPaper	LUM PPP
11 ChemicalsOilPr	P_C CRP
12 MetalMineralProducts	NMM I_S NFM FMP
13 MachineryEquipment	MVH ELE OME OTN OMF
14 OtherServices	GDT WTR ELY OFI ISR OBS ROS DWE
15 Construction	CNS
16 TradeCommunication	TRD CMN OTP WTP ATP
17 PublicServices	OSG

Table 25: GTAP sector labels

		GTAP 5 Sectors	
PDR	Paddy rice	LUM	Wood products
WHT	Wheat	PPP	Paper products, publishing
GRO	Cereal grains nec	P_C	Petroleum, coal products
V_F	Vegetables, fruit, nuts	CRP	Chemical, rubber, plastic products
OSD	Oil seeds	NMM	Mineral products nec
C_B	Sugar cane, sugar beet	I_S	Ferrous metals
PFB	Plant-based fibers	NFM	Metals nec
OCR	Crops nec	FMP	Metal products
CTL	Bovine cattle, sheep and goats, horses	MVH	Motor vehicles and parts
OAP	Animal products nec	OTN	Transport equipment nec
RMK	Raw milk	ELE	Electronic equipment
WOL	Wool, silk-worm cocoons	OME	Machinery and equipment nec
FOR	Forestry	OMF	Manufactures nec
FSH	Fishing	ELY	Electricity
COL	Coal	GDT	Gas manufacture, distribution
OIL	Oil	WTR	Water
GAS	Gas	CNS	Construction
OMN	Minerals nec	TRD	Trade
CMT	Bovine meat products	OTP	Transport nec
OMT	Meat products nec	WTP	Water transport
VOL	Vegetable oils and fats	ATP	Air transport
MIL	Dairy products	CMN	Communication
PCR	Processed rice	OFI	Financial services nec
SGR	Sugar	ISR	Insurance
OFD	Food products nec	OBS	Business services nec
B_T	Beverages and tobacco products	ROS	Recreational and other services
TEX	Textiles	OSG	Public Administration, Defense, Education, Health
WAP	Wearing apparel	DWE	Dwellings
LEA	Leather products		