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The Impact of Crisis-related Changes in Trade Flows on Employment, Incomes, Regional and Sectoral Development in Brazil

Scott McDonald
Marion Jansen
Erik von Uexkull

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Preface

The primary goal of the ILO is to contribute, with member States, to achieve full and productive employment and decent work for all, including women and young people, a goal embedded in the ILO Declaration 2008 on *Social Justice for a Fair Globalization*[1], and which has now been widely adopted by the international community.

In order to support member States and the social partners to reach the goal, the ILO pursues a Decent Work Agenda which comprises four interrelated areas: Respect for fundamental worker's rights and international labour standards, employment promotion, social protection and social dialogue. Explanations of this integrated approach and related challenges are contained in a number of key documents: in those explaining and elaborating the concept of decent work[2], in the Employment Policy Convention, 1964 (No. 122), and in the Global Employment Agenda.

The Global Employment Agenda was developed by the ILO through tripartite consensus of its Governing Body's Employment and Social Policy Committee. Since its adoption in 2003 it has been further articulated and made more operational and today it constitutes the basic framework through which the ILO pursues the objective of placing employment at the centre of economic and social policies[3].

The Employment Sector is fully engaged in the implementation of the Global Employment Agenda, and is doing so through a large range of technical support and capacity building activities, advisory services and policy research. As part of its research and publications programme, the Employment Sector promotes knowledge-generation around key policy issues and topics conforming to the core elements of the Global Employment Agenda and the Decent Work Agenda. The Sector's publications consist of books, monographs, working papers, employment reports and policy briefs[4].

The Employment Working Papers series is designed to disseminate the main findings of research initiatives undertaken by the various departments and programmes of the Sector. The working papers are intended to encourage exchange of ideas and to stimulate debate. The views expressed are the responsibility of the author(s) and do not necessarily represent those of the ILO.

José Manuel Salazar-Xirinachs
Executive Director
Employment Sector

[1] See http://www.ilo.org/public/english/bureau/dgo/download/dg_announce_en.pdf
[2] See the successive Reports of the Director-General to the International Labour Conference: *Decent work* (1999); *Reducing the decent work deficit: A global challenge* (2001); *Working out of poverty* (2003).
[3] See http://www.ilo.org/gea. And in particular: *Implementing the Global Employment Agenda: Employment strategies in support of decent work, "Vision" document*, ILO, 2006.
[4] See http://www.ilo.org/employment.

Contents

Abstract[5]

This study uses the STAGE-LAB Computable General Equilibrium Model to analyse the potential impact of the trade shock associated with the Great Recession on labour and household income in Brazil. Our model assumes that high skilled labour is fully employed, while there is oversupply of labour in the market for medium skill and low skilled labour. Labour market adjustment for high skilled labour thus takes the form of wage adjustments. For low and medium skilled workers, instead, labour market adjustments lead to changes in employment levels. The Social Accounting Matrix used in our study allows us to distinguish seven regions within Brazil and we allow for the possibility that high skilled labour migrates across regions in response to wage changes. We consider the trade shock to be temporary and therefore assume that capital and land are fixed by activity. For our base case scenario we find a modest but appreciable GDP reduction of 2.1 per cent caused by reductions in trade flows during the crisis. Average returns to land and to capital increase during the period in some regions. All types of labour lose out in the crisis, with low and medium skilled labour losing more than high skilled labour.

JEL Codes: E24, F16, F17

Key words: Brazil, trade, employment, Great Recession

[5] Disclaimer: This paper represents research in progress. It represents the opinion of the authors and is not meant to represent the position or opinions of the ILO or its Members, nor the official position of any staff members. The authors thank Ralf Peters and participants in the ETSG2010 (Lausanne) and GTAP2010 (Penang) conferences for useful comments. Any errors are the fault of the authors.

1. Introduction

The global financial crisis and the resulting drop in demand have caused unprecedented declines in world trade. According to (Freund, 2009), world trade fell by 30 per cent in value terms and 15 per cent in volume terms in the first quarter of 2009 compared to the same quarter of the previous year. Trade has been one of the channels through which what began as a financial crisis in the developed world has quickly spread to developing countries, turning it into a global economic crisis that severely threatens progress in poverty reduction and employment creation around the world.

Brazil is often referred to as a country that has weathered the crisis fairly well. On a quarter-to-quarter basis, growth turned positive again in the second quarter of 2009 after two quarters of contraction. The relative resilience of growth has often been attributed to Brazil's large domestic market and strong macroeconomic fundamentals. While all this is good news, experience from past crises shows that employment effects often materialize with a time-lag and recovery is much slower than for GDP growth. Furthermore, despite the moderate aggregate effect on growth, the trade shock is likely to lead to a re-allocation of resources both between sectors and within sectors with potentially substantial consequences for individual workers and households.

This study uses the STAGE_LAB Computable General Equilibrium Model (CGE) to examine the potential impact of the trade shock associated with the Great Recession on labour and household incomes in Brazil. The purpose is to improve the understanding of the mechanisms through which the crisis was transmitted through international trade to the level of workers and their families in Brazil and to give some indicative figures of the magnitude this impact might take.

The model and its specifications are similar to those used in a previous study that analysed the gains from trade in Brazil and the potential impact of a number of future scenarios for trade policy (Polaski, et al., 2009). This study found relative small overall gains from trade, but significant re-allocation of resources as a result of trade liberalization. The model allows for the analysis of labour market and income effects at great detail, including a breakdown of results by income level and region. The latter is particularly important given the large difference in income between the regions in Brazil. The model also prompts a number of methodological innovations, including labour migrations between regions and the ability to take into account unemployment in the unskilled segments of the labour market, which are explained in more detail in section 3.

A number of previous studies have analyzed the impact of trade on Brazil before the global economic crisis. In terms of global studies, (OECD, 2005) in a global simulation of the impact of a universal 50 per cent tariff cut and a 50 per cent reduction agricultural subsidies predicts welfare gains of approximately 0.3 per cent of GDP for Brazil, the main part of which would be caused by agricultural reform in OECD countries. (Anderson, Martin, & van der Mensbrugghe, 2006) in a long term simulation for an ambitious Doha agenda liberalization round predict welfare gains for Brazil of around 0.5 per cent by 2015 and demonstrate that these results are extremely sensitive to any exceptions or remaining restrictions on agriculture. (Bouet, Mevel, & Orden, 2007) explore a liberalization scenario directed mainly towards high agricultural tariffs in industrialized countries and predict welfare gains between 0.1 to 0.3 per cent of GDP for Brazil.

A number of studies based on single country models have also focused specifically on Brazil. (Polaski, et al., 2009) – mentioned above - analyze the impact of a conclusion of the Doha round and a number of south-south-trade arrangements. They also look at the

impact of external factors, namely the growth of India and China and fluctuations in commodity prices. They predict welfare increases equivalent to 0.4 per cent of GDP for both their Doha scenario and a comprehensive south-south-trade agreement. (Azzoni, Brooks, Guilhoto, & McDonald, 2007) predict that the gains of a Doha liberalization scenario would benefit most households, but mainly those involved in agriculture and especially commercial agriculture and large farms. (Bussolo, Lay, & van der Mensbrugghe, 2006) predict that under current conditions, the poverty headcount in Brazil would decline 5.6 per cent by 2015, and that with Doha liberalization this would increase only marginally by 0.2 per cent. Even if world trade was liberalized completely, they predict an additional decline of poverty by no more than 0.5 per cent. (Ferreira, Bento, & Horridge, 2010) predict that full global liberalization of agriculture would lead to an increase of 0.13 per cent in Brazil's GDP and a 3 per cent reduction in the number of poor households. In conclusion, previous studies have generally found small impacts of trade policy changes and other trade shocks on Brazil, but some of them point to the potential for substantial re-allocation among sectors producing both winners and losers.

The studies mentioned so far have in common that they focus on "positive" trade shocks triggered by trade liberalization. This paper, instead, focuses on a "negative" trade shock triggered by economic crisis in partner countries during the Great Recession.

The value of both Brazilian imports and exports declined substantially during the crisis, in particular in the last quarter of 2008 and the first quarter of 2009. In the first quarter of 2009, for instance, exports were 19 per cent and imports 22 per cent below their value in the same quarter of 2008[6].

The contraction in trade was not the only channel through which the global economic crisis affected Brazil. Between August and December 2008, the exchange rate went from 1.6 to 2.4 Real / US$. Since then, it regained value and returned close to its pre-crisis level towards the end of 2009. Changes in portfolio investment flows are likely to have been one of the drivers of this phenomenon.

Brazilian employment suffered during the Great Recession, albeit less than in other countries. Total employment dropped slightly in the first quarter of 2009, a decline mainly caused by a sharp drop in manufacturing employment. Construction employment also declined slightly in the beginning of the crisis but recovered relatively quickly. Employment in services and commerce were not strongly affected and continued to grow. The average unemployment rate increased from 6.8 per cent in December 2008 to 9.0 per cent in March 2009 but then declined again to 7.7 per cent in November 2009. It is interesting to note that the impact of the crisis on unemployment was considerably stronger in the industrial region of Sao Paulo, while unemployment in the region of Rio de Janeiro hardly increased at all during the crisis.

Taking into account that Brazil – unlike the U.S. and a number of European countries - has not been affected by a home-grown financial crisis, the employment fluctuations during the great recession are likely to have been triggered to a large extent by external factors. This paper focuses on the possible employment effects of the changes in trade flows triggered by the drop in demand for imports in Brazil's trading partners during the Great Recession. This is done using a STAGE-LAB Computable General Equilibrium Model to analyse the potential impact of the relevant trade shock on labour and household income according to five types of labour and across seven regions in Brazil. In order to adjust labour market specifications to the Brazilian situation, it is

[6] It is important to note that these are value changes which to some extent are driven by changes in world market prices.

assumed that the two high skilled labour types are fully employed, while there is oversupply of labour in the market for medium skill and two types of low skilled labour. Labour market adjustment for high skilled labour thus takes the form of wage adjustments. For low and medium skilled workers, instead, labour market adjustments lead to changes in employment levels. The Social Accounting Matrix used in our study allows us to distinguish seven regions within Brazil and we allow for the possibility that high skilled labour migrates across regions in response to wage changes. Unlike studies analysing employment effects of trade reform, we consider that the trade shock associated with the Great Recession is temporary. We therefore assume that capital and land remain fixed by activity.

The remainder of this paper is organised as follows: Section 2 gives some background by discussing the structure of the Brazilian economy with a focus on the role of trade for employment. Section 3 presents the model and its specifications as well as the Social Accounting Matrix (SAM) and the trade data used to define the shock of the economic crisis. Section 4 discusses the specifications for the policy shocks and the model closure. Section 5 presents the results and analyses their implications for employment and income distribution in Brazil, and section 6 concludes.

2. Exposure of the Brazilian labour market to trade

Trade plays a rather limited role in the overall structure of the Brazilian economy which is not unusual for a country as large as Brazil. Since 2002, the exports to GDP ratio was between 10 per cent and 16 per cent with a slight downward tendency before the Great Recession. During the same period, imports / GDP increased slightly, but remained below exports / GDP[7]. The value of exports grew from $53 bln. to $160 bln. between 1997 and 2007 and imports increased from $65 to $120 bln[8]. The most important export sectors in 2007 were mineral extraction, machinery, vehicles other than automobiles and spare parts, and other food products. However, the export structure is rather diversified and a number of other sectors, both primary and higher value added products, play an important role in the export portfolio. The strongest growth was in petrol extraction and petrol products that were virtually non-existent in 1997 while by 2007 they accounted for around $13 bln. – Nearly 10 per cent of exports. Imports of livestock products also increased very strongly. Machinery and petrol and gas extraction accounted for the largest import values in 2007. It can be noted that most imports are in investment goods or industrial inputs, while typical consumer goods such as food products or apparel only account for a very small share of the import bill. The strongest import growth was in refined petrol products that went from close to zero in 1997 to around $7 bln. in 2007.

With the onset of the crisis, both imports and exports fell disproportionately and thus declined relative to GDP. In the absence of data reflecting the full trade shock at the time of writing this paper, we use mirror data on trade with Brazil reported by the US and the European Union and define the shock as the percentage change in trade between January-April 2009 and the same period in the previous year. Together, the European Union and the United States accounted for around 40 per cent of Brazilian exports and Brazilian imports before the Great Recession. Based on our assumption, export drops during the crisis were largest in iron (63 per cent), mineral extraction (59 per cent), and non-ferrous metals[9]. Vehicles other than automobiles (-48 per cent), machinery (-45 per cent) and other metal products (-39 per cent) also declined very strongly. The total volume of exports to the EU and US declined by 23 per cent. Assuming that exports to the rest of the world remained unchanged, this would translate into a 9 per cent decline in total exports.

For imports, the strongest declines were in other agriculture (-66 per cent), leather products (-58 per cent), refined petrol products (-54 per cent) and livestock products (-50 per cent). The total volume of imports from the EU and US declined by 26 per cent, which is a stronger decline than that experienced for exports.

The employment impacts of such a negative trade shock will to a large extent depend on importance of trade for production in the relevant sectors and on the labour intensity of the sectors most affected. Table 1 gives an overview of that share of output exported and the labour intensity measured as the wage share in total output by sector based on information available in the Social Accounting Matrix for Brazil developed for Polaski et al. 2009. The share of output exported gives a rough indication of the exposure of a sector to shocks in global demand. The wage share in a sector's output gives an indication of the extent to which workers are affected by any given shock to the sector. Mineral extraction (40 per cent) and non-ferrous metals (40 per cent) have the highest export share, followed by soybean (35 per cent), leather products (29 per cent), sugar (28 per cent), vehicles other than automobiles and spare parts (26 per cent). Iron (25 per cent), wood and furniture (22 per cent) and automobiles (20 per cent) also have relatively

[7] Both imports and exports are reported excluding cost, freight and insurance cost.
[8] Based on COMTRADE data. We use 2007 rather than 2008 as the last year for the discussion of long term growth trends in order to avoid the strong value changes associated with the commodity price hike in 2008.
[9] See Section 3 of this paper for more detail.

high export exposure. In agriculture, soybeans (34.5 per cent) have a high proportion of exports, but information on the wage bill is not available for agricultural sectors in the SAM.

Even in sectors with high numbers of low-wage workers, the wage bill for low and very low wage labour typically only accounts for a very small fraction of output. The highest low wage labour bills are in the within the services sector and mainly in non-tradable services. In the merchandise sector, textile and apparel have the largest share of very low and low wage employment. In Brazil, these sectors are oriented mainly towards the domestic market. High and very high wage labour bills are also the highest in the services sector. The wood and furniture and leather industries have both high exposure to exports and a high share of labour in all but the very low wage segment.

Table 1. Export Orientation and Labour Intensity by Sector

	Output	of which exported	of which wage bill v low	of which wage bill low	of which wage bill medium	of which wage bill high	of which wage bill v high	of which total wage bill
Sugar Cane	12,586	0.6%						
Soybean	42,821	34.5%						
Other agriculture	128,691	8.0%						
Livestock	63,175	3.0%						
Mineral Extraction	39,819	40.3%	0.02%	0.35%	1.36%	2.50%	3.26%	7.48%
Petrol and Gas Extraction	79,293	9.4%	0.00%	0.00%	0.24%	1.01%	5.98%	7.23%
Non metallic minerals	44,255	9.8%	0.08%	0.89%	4.29%	3.89%	4.32%	13.47%
Iron	82,348	24.8%	0.02%	0.18%	1.62%	2.62%	2.48%	6.91%
Non ferrous metals	24,221	40.0%	0.02%	0.18%	1.60%	2.58%	2.45%	6.83%
Other metal products	57,354	5.9%	0.04%	0.41%	3.72%	5.99%	5.67%	15.83%
Machinery	97,015	15.7%	0.01%	0.13%	1.89%	4.24%	4.68%	10.95%
Electric materials	59,816	9.2%	0.01%	0.15%	1.87%	2.99%	4.78%	9.80%
Electronic Equipment	110,894	6.7%	0.01%	0.09%	1.10%	1.76%	2.81%	5.76%
Automobiles	90,211	19.7%	0.00%	0.04%	0.70%	1.97%	2.99%	5.70%
Other vehicles and spare parts	100,153	26.2%	0.00%	0.07%	1.43%	4.05%	6.13%	11.69%
Wood and furniture	53,516	21.7%	0.09%	1.09%	6.17%	5.21%	2.81%	15.38%
Paper and graphic	83,150	10.3%	0.02%	0.30%	2.71%	3.89%	7.03%	13.95%
Rubber products	22,200	11.7%	0.01%	0.17%	1.42%	3.02%	6.47%	11.10%
Chemical elements	59,147	5.1%	0.00%	0.07%	1.46%	2.90%	1.29%	5.72%
Refined petrol products	242,477	6.5%	0.00%	0.01%	0.10%	0.32%	1.93%	2.36%
Other chemical products	52,916	6.7%	0.03%	0.25%	1.43%	2.11%	4.24%	8.06%
Pharmaceuticals	84,971	2.9%	0.01%	0.14%	1.42%	2.02%	4.73%	8.31%
Plastics	37,922	3.8%	0.01%	0.47%	4.14%	3.70%	4.24%	12.54%
Textiles	44,375	10.0%	0.75%	1.21%	4.67%	3.88%	4.06%	14.55%
Apparel	38,359	2.6%	0.54%	3.16%	10.47%	5.50%	3.69%	23.35%
Leather products	31,284	28.8%	0.08%	1.26%	8.42%	3.04%	3.82%	16.61%
Processed coffee products	7,484	11.5%	0.07%	0.50%	2.17%	1.96%	1.50%	6.20%
Livestock products	101,647	17.4%	0.08%	0.58%	2.55%	2.31%	1.76%	7.28%
Sugar	28,148	28.1%	0.11%	0.81%	3.57%	3.23%	2.47%	10.19%
Other food products	210,474	11.7%	0.07%	0.53%	2.31%	2.09%	1.60%	6.60%
Other manufacturing	19,808	6.1%	0.17%	0.72%	3.07%	3.62%	4.53%	12.11%
Public Utilities	147,386	0.0%	0.01%	0.36%	1.47%	2.57%	4.52%	8.92%
Civil construction	162,468	0.6%	0.24%	2.17%	11.28%	7.73%	5.41%	26.83%
Trade	262,252	0.2%	0.47%	2.88%	11.74%	12.86%	15.69%	43.64%
Transport	170,049	8.0%	0.11%	0.70%	4.95%	10.80%	10.61%	27.18%
Communications	109,664	0.8%	0.01%	0.12%	1.57%	2.50%	4.60%	8.80%
Financial services	179,576	1.0%	0.01%	0.21%	1.86%	6.34%	17.59%	26.01%
Services to families	249,713	5.2%	0.70%	3.77%	9.37%	9.92%	14.09%	37.84%
Services to enterprises	198,781	6.2%	0.07%	1.09%	6.34%	8.69%	20.67%	36.86%
Dwellings	166,283	0.7%	0.01%	0.12%	1.05%	1.01%	1.40%	3.59%
Public administration	379,020	0.2%	0.05%	1.90%	5.89%	15.13%	33.41%	56.37%
Non mercantile private services	59,529	1.6%	0.67%	3.92%	11.19%	14.71%	23.88%	54.38%

Source: SAM constructed by Joaquim Bento de Souza Ferreira Filho as described in (Polaski, et al., 2009)

Table 1 gives useful indications about the direct exposure of employment in individual sectors to trade shocks, but in order to actually measure the impact of a trade shock on employment it is also necessary to take into account how employment effects trigger through the economy because of forward and backward linkages among sectors. Individuals, firms and the government may also change their behaviour in response to a trade shock which may also have to be taken into account.

Different methods exist to evaluate the employment impact of a temporary trade shock. Kucera et al. (2010) (Kucera, Roncolato, & Von Uexkull, 2010) recently used a Leontieff Multiplier Model to examine the employment impact of trade shocks occurring during the Great Recession on the Indian and the South African economy. In this paper, instead, we use a Computable General Equilibrium model, the specification of which will be described in the next section.

3. Model and Data

The Model

The model used in this study is a development of the STAGE (Static Applied General Equilibrium) model called STAGE_LAB. STAGE_LAB is a member of the STAGE suite of single country computable general equilibrium models. Conceptually, it falls into the class of models that follow the approach described by (Derivis, de Melo, & Robinson, 1982) and the models developed by (Robinson, Kilkenny, & Hanson, 1990) and (Kilkenny, 1991). At the core of the suite is the basic STAGE model customised to the setting/economic environment being explored in this paper.

The basic STAGE model is characterised by several distinctive features. First, the model allows for a generalised treatment of trade relationships by incorporating provisions for non-traded exports and imports. Second, the model allows the relaxation of the small country assumption for exported commodities that do not face perfectly elastic demand on the world market. Third, the model allows for (simple) modelling of multiple product activities through an assumption of fixed proportions of commodity outputs by activities with commodities differentiated by the activities that produce them. Hence the numbers of commodity and activity accounts are not necessarily the same; this captures the empirical fact that real activities/industries typically produce multiple commodities/products and while for many manufacturing and services activities secondary products are relatively unimportant this is far from the case for agriculture[10]. Fourth, (value added) production technologies are specified as nested Constant Elasticity of Substitution (CES). And fifth, household consumption expenditure is modelled using Stone-Geary utility functions; these yield linear expenditure systems that allow for minimum levels of consumption of commodities, which is valuable when modelling consumption choices by households with very low incomes. In the model used for this paper, the country is assumed to be a price taker for all imported commodities.

The additional features added for the STAGE_LAB version are the inclusion of a generalised system of nested CES functions for the representation of production, the endogenous modelling of unemployment for all factors through a regime switching mechanism and the ability for factors to migrate between regions/areas and/or factor 'classification', e.g., between semi-skilled and unskilled labour. Except for a few minor changes – that imply no differences in behavioural relationship[11] – other features of the STAGE model are carried over directly to STAGE_LAB. More detailed information on the model used in this paper is provided in the Appendix.

[10] An additional advantage is that the requisite databases can be compiled from the directly observed transactions data in Supply and Use tables rather than the transformed data in Input-Output tables. Thus output composition choices are modelled explicitly rather than being subsumed into data transformation processes.

[11] The main difference is through the addition of some extra sets to control the modelling of labour market transactions.

The endogenous modelling of unemployment is achieved by defining the supply of each factor by reference to current total demand PLUS the stock of the factor currently unemployed. In the case of labour, if there is current unemployment for a class of labour, e.g., unskilled, the real wage of that class is fixed until all the stock of unemployed unskilled workers have been absorbed by the labour market and thereafter the real wage of the factor is flexible[12]. This form of regime switching is attractive since it increases the realism with which the labour markets are modelled, but it does have some implications for the modelling of cross regional labour migration. Given that labour migration decisions depend on changes in relative wage rates there can only be net migration when a factor within a migration pool is fully employed, since only then can relative wages change.

In this paper we assume that low skilled workers (i.e. very low wage and low wage earners) and medium skilled workers (i.e. medium wage earners) can be unemployed. High skilled workers (i.e. high and very high wage earners) are assumed to be fully employed. High and very high wages are therefore the only wages that are flexible and cross regional migration only happens in the high skill labour market segment.

Database: Social Accounting Matrix, Trade Shock Data and Elasticities

Social Accounting Matrix

The model described above is designed for calibration using a reduced form of a Social Accounting Matrix (SAM) that broadly conforms to the UN System of National Accounts (SNA). This approach has been influenced by (Pyatt, 1987).

The SAM used in this study was constructed by Joaquim Bento de Souza Ferreira Filho. It is described in greater detail in (Polaski, et al., 2009). It improves upon earlier SAMs for the Brazilian economy by updating the economic data to the year 2004. Another characteristic of this SAM is the degree of regional detail, with information for the 27 regions inside Brazil (26 states plus the Federal District). It also provides a disaggregated representation of labour and households, with ten different labour types and ten different household groups. For the purposes of this study the SAM was reduced by aggregation to 7 regions with 42 commodity accounts, 45 activities, 7 (region specific) types of land, 7 (region specific types of capital, 35 types of labour (5 different labour types by 7 different regions) and 7 (region specific) households together with a series of other institutional accounts and multiple tax instruments[13]. Details of the accounts are reported in Appendix A.

[12] In terms of the model this requires that the model operates with one regime when there is unemployment and another regime when there is full employment. This regime switching is achieved by specifying the model as mixed complementarity problem (MCP). The variant used here generates a two segments labour supply function – horizontal until full employment and then vertical – but more complex options are possible, e.g., three segments – horizontal until unemployment rate fall below some level, upward sloping until full employment and thereafter vertical.

[13] There are 4 taxes on commodities, 2 on activities, income taxes on household and enterprises and factor specific use taxes that vary by the employing activity. Not all the tax instruments are active in the base data.

Measuring the exogenous trade shock

Given that detailed monthly data on import and export values and quantities at the product level were not available when this paper was written, we reverted to mirror data on trade with Brazil reported by the US and the European Union. Together, they accounted for 41 per cent of Brazil's total exports and 39 per cent of total imports in 2007[14]. The data used come from the United States International Trade Commission (USITC) and EUROSTAT. It includes the value and quantity of monthly imports and exports at tariff line level and thus allows for the calculation of changes at constant prices in imports and exports at the product level as required to calculate the trade vector used in the model[15]. Imports and exports at constant prices were calculated at the tariff line level as the quantity of imports / exports multiplied by the average unit value (value / quantity) in the base year 2007 to be consistent with the other data in the SAM. For products where no sufficient information was available for 2007, the current value was used. Finally, the trade data were aggregated to the sectors used in the SAM. To isolate the impact of the crisis, the three months that arguably saw the peak impact of the trade shock in Brazil (Jan-Apr 2009) were compared with the same three months in 2008 to calculate percentage changes.

Table 2 shows the resulting data for the trade shock. The first column presents the percentage changes in export volumes with the EU and US calculated as described above. Simply applying these percentage changes to Brazil's total would likely lead to an overestimation of the trade shock as the contraction in demand in the EU and US was particularly strong during the crisis. Thus, the second column shows a hypothetical export shock with all trading partners if it is assumed that exports to the rest of the world remain unchanged (it is thus a function of the first column and the shares of EU, US and rest of the world in total exports for each sector). This leads to a much more conservative approximation of the total trade shock.

[14] COMTRADE database.

[15] The ability to augment the SAM by using directly observed data is one of the advantages of distinguishing between commodities and activities. If the SAM had been constructed around a 'standard' format input-output table these trade data would have required transformation to achieve definitional consistency.

Table 2. Export Shock as used in the Model

	Exp volume change EU & US	Exp volume change world
Sugar Cane	0.0%	0.0%
Soybean	31.2%	12.8%
Other agriculture	-21.5%	-14.2%
Livestock	-13.6%	-4.3%
Mineral Extraction	-57.8%	-18.3%
Petrol and Gas Extraction	39.0%	21.9%
Non-metallic minerals	-32.8%	-19.1%
Iron	-62.6%	-30.5%
Non-ferrous metals	-56.9%	-26.9%
Other metal products	-39.0%	-13.1%
Machinery	-45.0%	-16.5%
Electric materials	-22.5%	-6.9%
Electronic Equipment	-22.5%	-6.9%
Automobiles	-14.5%	-2.5%
Other vehicles and spare parts	-48.0%	-17.8%
Wood and furniture	-29.9%	-20.6%
Paper and graphic	20.2%	5.9%
Rubber products	-23.6%	-8.6%
Chemical elements	-12.2%	-5.0%
Refined petrol products	-17.3%	-2.4%
Other chemical products	6.8%	1.1%
Pharmaceuticals	66.7%	15.7%
Plastics	-7.7%	-2.0%
Textiles	-35.9%	-12.0%
Apparel	-26.9%	-17.2%
Leather products	-26.9%	-13.1%
Processed coffee products	-24.7%	-21.0%
Livestock products	-8.2%	-2.4%
Sugar	-25.6%	-1.3%
Other food products	-2.0%	-1.1%
Other manufacturing	-10.8%	-6.7%
TOTAL	-23.0%	-9.4%

Source: Authors' calculation based on data from USITC and Eurostat

Elasticities

The elasticities selected for this study required substantial assumptions because of the lack of empirical evidence for Brazil or other similar economies. The base elasticities are reported in Annex 3 and Annex 4. A deliberate decision was taken to limit the number of different elasticity values and this is reflected in the chosen values.

4. Policy Shocks and Model Closure

The model is implemented using two different configurations of macroeconomic closure and market clearing conditions. In many ways, these configurations are identical. The common properties are

1. The exchange rate is flexible and the balance on the current account is fixed – this ensures no change in aggregate foreign debt is passed onto future generations and that the exchange rate adjusts to clear the foreign account;

2. the internal balance – government savings – is fixed, as are all tax rates except the income tax rates paid by households, which are free to adjust equiproportionately to clear the government account;

3. the volume of investment is fixed, i.e., the capital stock passed onto the next year is fixed, which with a fixed internal balance means that household savings rates adjust to clear the capital account;

4. the market clearing condition for the factor markets are for a short run adjustment, specifically:

    a. capital is assumed to be fixed and immobile between activities;

    b. land is region specific, as are the agriculture accounts and is therefore fixed;

    c. skilled labour – the very high and high wage categories for each region – is assumed to be fully employed and mobile between activities;

    d. semi-skilled and unskilled labour is assumed to subject to the possibility of unemployment, therefore if activities choose to employ more of these types of labour they can do so at a fixed real wage rate until the labour type is fully employed when the wage rate becomes flexible and if activities choose to reduce employment of these labour types the wage rate reduces until it reaches the fixed minimum real wage rate after which unemployment increases; and

    e. labour is mobile across regions in response to changes in the relative wages rates of each skill class of labour across regions, thus if relative wages for a labour type in a region rise and that labour type is fully employed then labour of that type will move into that region.

The differences between the two configurations relate to the treatment of import and export prices and quantities. In both configurations it is assumed that export quantities are fixed, i.e. made exogenous, and the world prices of exports, denominated in foreign currency units, are made flexible, i.e. endogenous. This allows us to "shock" the model with the export changes that have actually been observed. Implicitly, this approach reflects the assumption that Brazil would choose to export the exogenously determined quantities. The two configurations differ in the way they handle import prices and quantities:

1. In configuration 1 import quantities are deemed to be endogenously determined subject to the assumption that the world prices of imports, in foreign currency units, are fixed. We call this scenario X shock.

2. In configuration 2 import quantities are also fixed, i.e., made exogenous, and the world prices, denominated in foreign currency units, are made flexible, i.e., endogenous, so that Brazil would choose to export and import the exogenously determined quantities. We call this scenario X&M shock.

The first alternative contains the explicit presumption that it is the changes in export prices that induce Brazilian producers to alter export supply decisions but that events in the rest of the global economy do not result in changes in the prices of imports; it thus analyzes the export shock in a 'ceteris paribus' scenario. In contrast, the second alternative treats imports and exports symmetrically; the observed changes in export and import volumes are presumed to be a consequence of Brazilian agents responding to changes in relative price signals that induce the observed changes in exports and imports; this presumption is arguably more consistent with the model specification which is built on the presumption that agents respond to price signals.

The different treatment of imports in the two configurations is reflected in Table 3. In both configurations, the volumes of exports are exogenously fixed and correspond to those in the first column of Table 3 (which is equivalent to the second column in Table 2). The second column in Table 3 reflects the estimated changes in import volumes under the assumption that world prices of imports, in foreign currency units, are fixed: The X-shock. Column 3 in Table 3 reflects the estimated changes of import volumes in the X&M scenario, i.e. the assumption that import changes are exogenous. Import volumes for the X&M scenario have therefore been calculated using mirror data of trade with Brazil as reported by the US and the EU and according to the methodology used to compute the export shock that has been explained in the previous section. In the case of imports, though, the percentage changes calculated based on the EU and US data are directly applied to reflect changes in imports from the rest of the world, as there is no indication of a disproportional shock on imports from the EU and US.

Table 3. Export and Import Volumes (% changes) according to Macro-economic Closure

	EXPORTS	IMPORTS	
	All scenarios	X Shock	X&M Shock
Soybean	12.76	-36.39	0.00
Other agric	-14.15	-59.84	-66.35
Livestock	-4.31	-66.61	-19.78
Mineral Extr	-18.34	-45.75	19.90
Petrol & Gas Extr	21.87	-31.88	-10.40
Minerals	-19.08	-53.48	-43.68
Iron	-30.54	-47.68	-30.94
Non ferrous	-26.87	-29.56	-33.88
Metal prod	-13.11	-32.91	-18.94
Machinery	-16.49	-24.81	-38.81
Electric materials	-6.94	-33.36	-21.96
Electronic Equip	-6.94	-24.00	-21.96
Automobiles	-2.50	-37.25	-44.94
Other vehicles	-17.82	-28.53	-14.28
Wood & prod	-20.55	-42.46	-24.94
Paper	5.93	-42.10	-41.83
Rubber prod	-8.60	-36.04	-39.70
Chemicals	-4.96	-31.34	-25.23
Petroleum prod	-2.42	-31.06	-54.10
Chemical prod	1.13	-31.59	-15.41
Pharma	15.68	-40.29	27.47
Plastics	-2.04	-42.09	-36.85
Textiles	-11.97	-49.88	-20.78
Apparel	-17.23	-52.94	-6.62
Leather	-13.13	-51.31	-57.88
Coffee prod	-20.99	-52.91	-10.04
Livestock prod	-2.42	-56.14	-50.43
Sugar	-1.32	-51.30	-12.56
Other foods	-1.06	-50.85	-19.14
Other manu	-6.67	-50.30	-17.88
Construction	0.00	na	0.00
Comms	0.00	na	0.00
Financial serv	0.00	na	0.00
Family serv	0.00	na	0.00

Source: Simulation results and authors' calculation based on data from USITC and Eurostat.

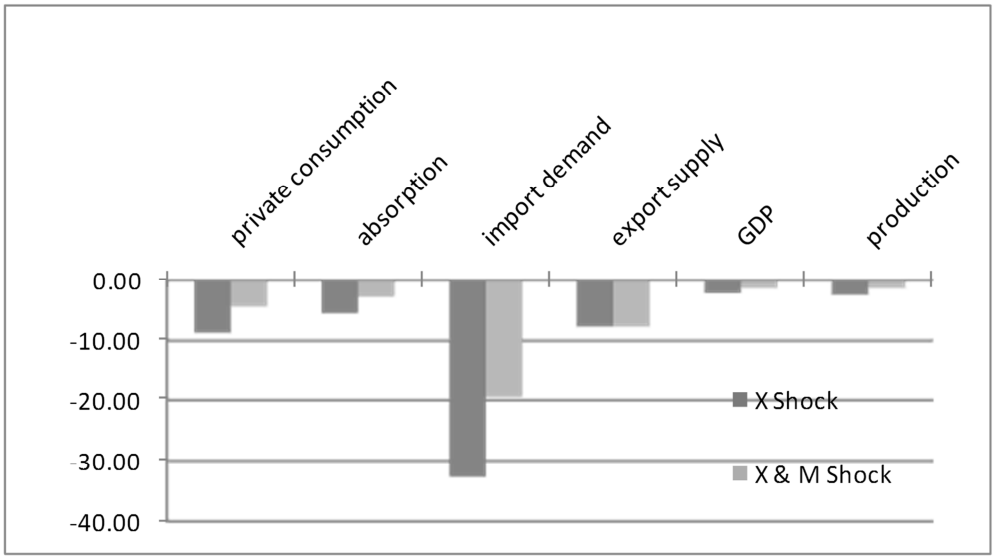
Since each of the reported configurations involves different response mechanisms, the vectors of world prices consistent with export volume changes also differ. If the world prices of imports – in foreign currency units – are fixed then the world prices of all imported commodities decline relative to domestic prices, while if import volumes are fixed the world prices of all imports rise. The decline in world prices is generated by the depreciation of the (nominal) exchange rate by 25.2 per cent in the case of the X-shock configuration, while the exchange rate is much less affected (estimated appreciation of 1.6 per cent) in the case of the X&M shock scenario. It could be argued that the depreciation corresponding to the X-shock is more closely in line with the exchange rate movements actually observed in the early stages of the Great Recession as discussed in the introduction.

5. Results and Analysis

The discussion of the results will concentrate on the results for the simulations where only export volume changes are simulated ('X-shock'); this will be referred to as the base case. Where the results from other simulations provide useful insights, the discussion will reference those results. The real macroeconomic impacts of the shocks are summarised in Figure 1. These indicate that in all cases the export declines simulated amount to an approximately 9 per cent reduction in real exports. In the base case ('X Shock'), where import prices in foreign currency unit are held constant, this generates small but appreciable reductions in GDP (-2.1 per cent), domestic production, absorption and private consumption[16].

If import volumes are also shocked ('X & M Shock') then the reductions in GDP, absorption and private consumption are ameliorated. This is because with world prices of imports fixed in scenario X shock, domestic responses to the export shocks are constrained and it is necessary for the economy to shrink by a greater amount than if the world prices of imports can adjust – in this case the adjustments are those generated in response to the imposed changes in import volumes. The additional contraction in domestic demand is manifest in terms of reduced volumes of domestic production and absorption, especially in private consumption that serves as a simple welfare metric.

Figure 1. Simulation Results: Real Macroeconomic Aggregates (% change)



Source: simulation results.

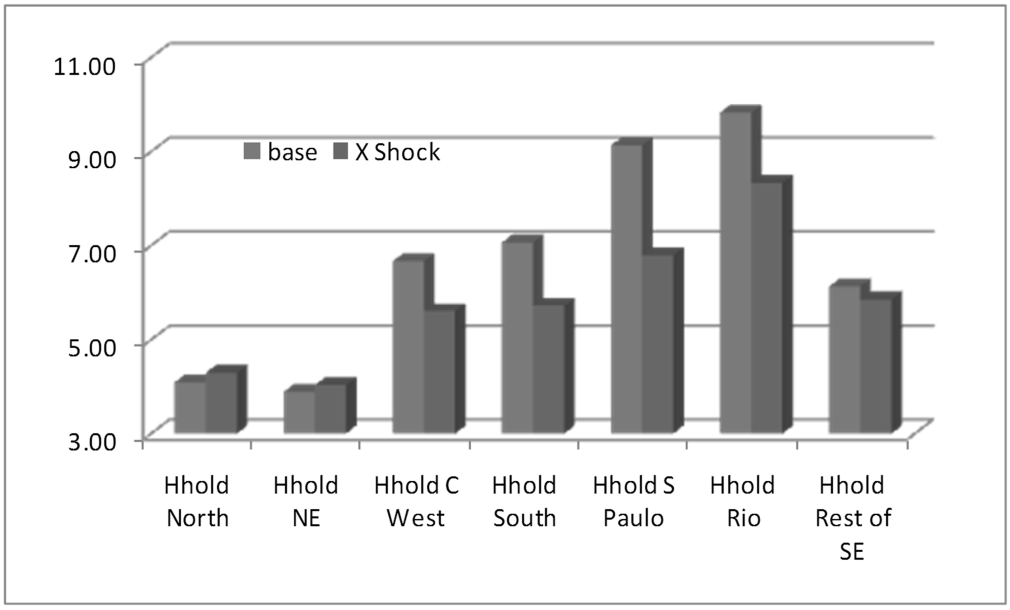
There is a notable tendency for the reductions in welfare, based on equivalent variations[17], to be greater in the relatively richer – more developed – regions of Brazil (Figure 2). As with the macroeconomic indicators the impact of holding world prices constant is an appreciably greater reduction in welfare in all regions. The magnitudes of the differences in base period welfare are illustrated in Figure 3, where the first column for each household records the value of base period consumption/welfare. These expenditures serve to indicate several important considerations. First the very large

[16] Because of the assumption that intertemporal adjustments are not permitted, all costs of the shock are concentrated in one period. This is one of the reasons why the presented simulated reductions in GDP, absorption and private consumption are more severe than the ones observed in reality.

[17] Equivalent variation is the change in income required to maintain the same level of welfare as in the base period when evaluated at base period prices.

differences between consumption expenditures across regions – those in the Rio Janeiro and Sao Paulo regions being more than twice those in the North and North East. Second the muted impacts of the shock for households in the North, North East and South East. And third, the small increases in real consumption expenditures in the North and North-East regions even though the regions experience small welfare losses.

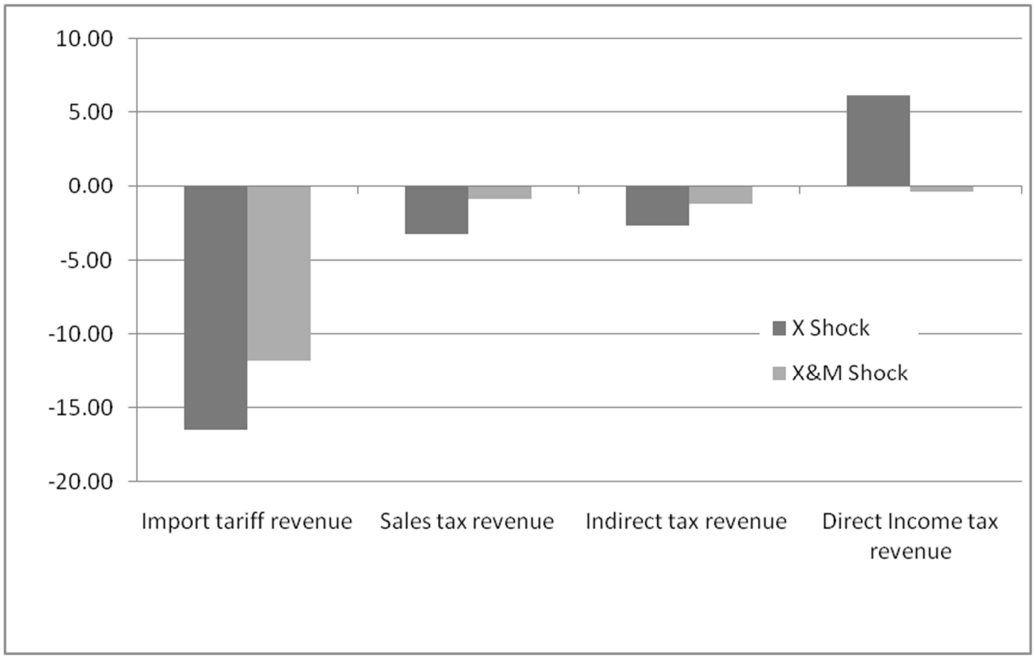
Figure 2. Real Household Consumption Expenditures ('00 real)



Source: simulation results.

The STAGE_LAB model also allows for an evaluation of the crisis impact on government revenues from taxes, which is interesting in the context of the on-going debate on government deficits triggered by the crisis. The model assumes that the government collects revenue through import tariffs, sales taxes, indirect taxes and direct income taxes. The model is set up in such a way that revenue from import tariffs, sales taxes and indirect taxes automatically adjusts with changes in the aggregates that are taxed. The direct income tax rates, instead, will be changed by the government in order to achieve a balanced budget. Figure 3 shows that under scenario X shock, the government would need to raise an additional 5 per cent of revenue in direct income taxes in order to balance for the losses from the other revenue sources that are triggered by the trade shock. Under scenario X&M shock, the effects of the import and the export shocks roughly offset each other and direct income tax revenue can remain largely unchanged.

Figure 3. Simulation Results: Changes in Tax Revenues (% change)



Source: simulation results.

The driving forces behind the changes in household consumption and welfare estimated in this paper are the induced changes in the factor markets and their implications for factor incomes. The incomes of different types of labour decline, and particularly so for the very low and low wage labour types: see Table 4. Similar patterns emerge for capital with declines in all regions. However, the declines in factor income for capital are smaller than those for low and very low wage labour in all regions. The declines in factor incomes are stronger in the X shock scenario than in the X&M shock scenario. It is notable that returns to land increase in one region – Centre West; this is because of increases in demand for the agricultural products predominantly produce in the Centre West.

Table 4. Simulation Results: Factor Incomes (% changes)

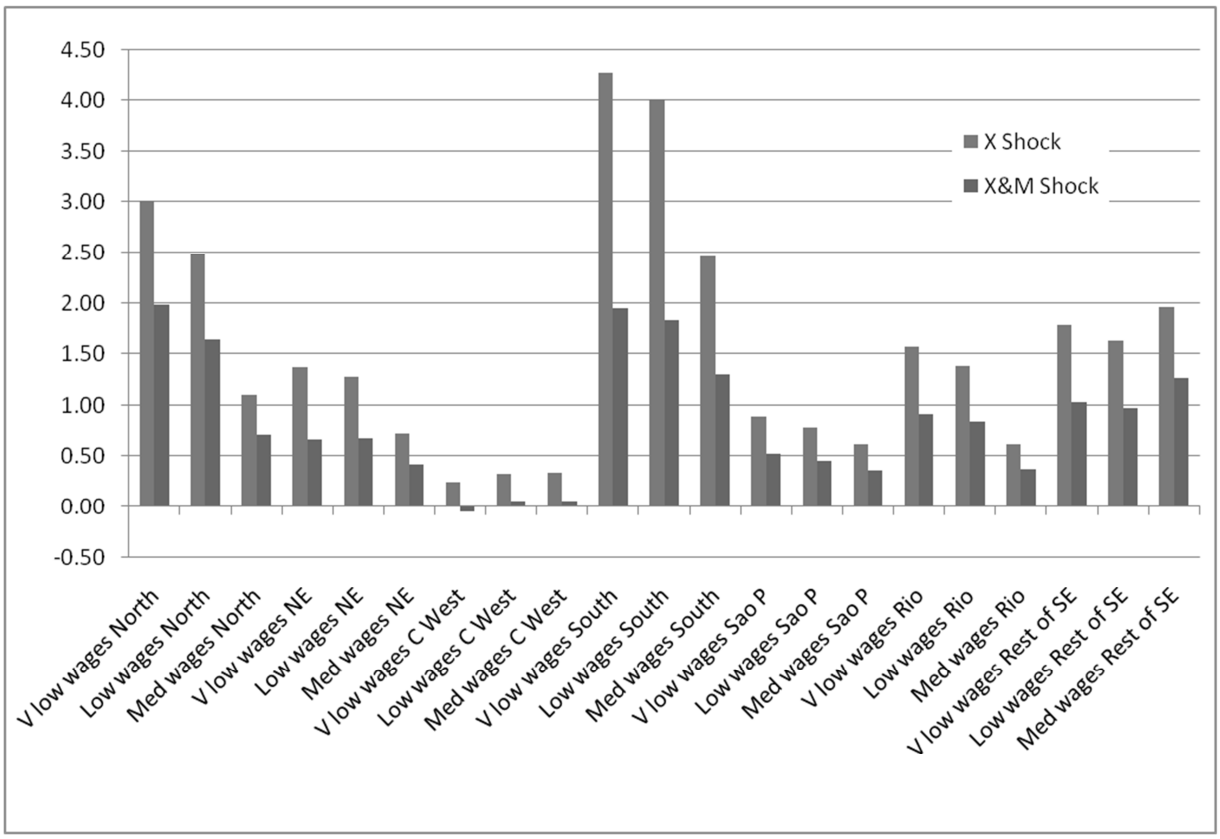
	X-Shock	X&M Shock
V low wages North	-11.15	-7.34
Low wages North	-9.24	-6.07
Med wages North	-7.37	-4.75
High wages North	-2.85	-1.91
V high wages North	-2.83	-1.89
V low wages NE	-7.27	-3.53
Low wages NE	-6.78	-3.57
Med wages NE	-6.09	-3.51
High wages NE	-2.48	-1.46
V high wages NE	-2.19	-1.20
V low wages C West	-1.60	0.29
Low wages C West	-2.13	-0.36
Med wages C West	-2.06	-0.38
High wages C West	-0.95	-0.31
V high wages C West	-1.08	-0.45
V low wages South	-6.00	-2.73
Low wages South	-5.64	-2.57
Med wages South	-5.94	-3.13
High wages South	-2.44	-1.24
V high wages South	-2.36	-1.18
V low wages Sao P	-7.43	-4.37
Low wages Sao P	-6.48	-3.78
Med wages Sao P	-5.68	-3.30
High wages Sao P	-2.56	-1.50
V high wages Sao P	-2.77	-1.76
V low wages Rio	-7.71	-4.51
Low wages Rio	-6.80	-4.07
Med wages Rio	-5.96	-3.60
High wages Rio	-2.44	-1.46
V high wages Rio	-1.41	-0.49
V low wages Rest of SE	-8.80	-5.07
Low wages Rest of SE	-7.99	-4.78
Med wages Rest of SE	-6.71	-4.30
High wages Rest of SE	-2.86	-2.08
V high wages Rest of SE	-2.94	-2.08
Capital North	-4.64	-3.36
Capital NE	-3.73	-1.83
Capital C West	-5.26	-3.32
Capital South	-4.75	-2.68
Capital Sao P	-5.10	-3.04
Capital Rio	-2.39	-0.69
Capital Rest of SE	-5.16	-4.63
Land North	-9.51	-6.45
Land NE	-5.48	-2.45
Land C West	6.37	5.88
Land South	-1.01	1.04
Land Sao P	-3.37	-1.12
Land Rio	-8.69	-5.66
Land Rest of SE	-6.97	-3.70

Source: simulation results.

The model assumes that land and capital are fixed and sector specific. High skilled labour is fully employed, but there is an oversupply of low and medium skilled labour that leads to unemployment. In this setup, a trade shock will generate changes in unemployment among low and medium skilled workers and wage changes for the high skilled. Because the model allows for high skilled labour to migrate across regions in response to wage difference, simulations allow for conclusions on migration pressures triggered by the simulated trade shock. Therefore, it is useful to subdivide factor incomes between those referring to the labour types that have the potential for unemployment, the labour types that are fully employed, and the fixed and sector specific factors land and capital.

The patterns of the effects on labour types that can be unemployed are illustrated in Figure 4. Very low wage earners suffer – often significantly – stronger increases in unemployment than low and medium wage workers in five out of seven regions in Brazil. The relatively small negative (or even slightly positive in scenario X&M shock) impact on very low skilled workers in Central West is again driven by the increase in demand for agricultural products.

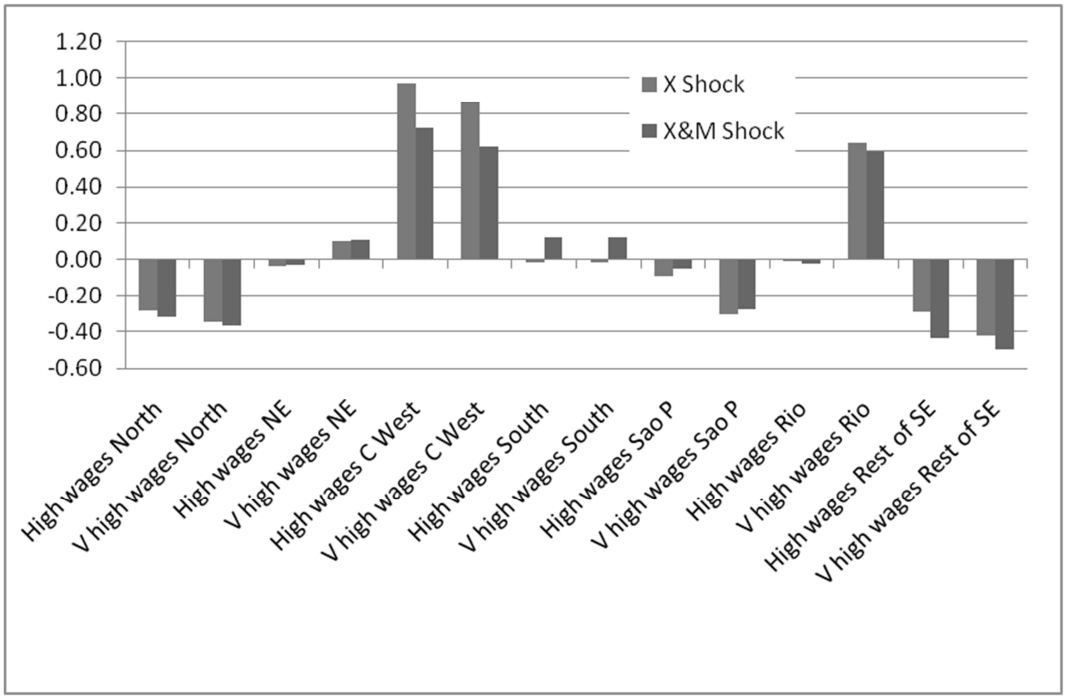
Figure 4. Simulation Results: Unemployment (% changes)



Source: simulation results.

The results on changes in employment of highly skilled labour due to migration (Figure 5) reflect the incentives for these types of labour to exit from the North, Sao Paulo and Rest of SE regions and migrate towards other regions, especially the Centre West and Rio Janeiro. This is broadly consistent with the pattern of impacts on unemployment for lesser skilled labour with the notable exception of Rio Janeiro, which experiences appreciable increases in unemployment among lesser skilled workers while also experiencing a strong increase in the wages of higher skilled workers; this reflect the patterns of production and sectoral employment in the Rio Janeiro region.

Figure 5. Simulation Results: Changes in Employment due to Labour Migration (% changes)



Source: simulation results.

More insight into the impacts upon factor incomes can be gained by examining the impacts upon payment rates to the aggregate factors by each activity[18]. For labour it is only aggregate labour employed by agriculture in the Centre West that experiences an average increase and then only for one simulations ('Shock X); elsewhere the impacts on labour are consistently negative. They are also relatively uniform, which is not surprising since it has been assumed that activities can adjust employment levels and that labour allocations will adjust. On the other hand for (aggregate) capital the impacts are mixed; again this is not surprising since export demand for some commodities increase while for others it decreases, which means that the prices received by activities for their outputs will increase or decrease respectively, but capital cannot reallocate to equalise returns. For activities outside of agriculture the processes are relatively simple since each activity produces a single commodity, but the agriculture activities are multi-product activities and therefore the driving force behind changes in land and capital returns depends upon both the mix of increasing and decreasing export demand and the mix of outputs in each agricultural activity (region). The Centre West and South agricultural activities/regions experience increases in overall export demand given their output mixes.

[18] NOTE: the payment rates have no real world counterparts, rather they are the implied rates of payment for the aggregates and can therefore be interpreted as summary measures (indices) that indicate the *average* changes across the broad categories.

Table 5. Factor Payment Rates by Aggregate Factors (% change)

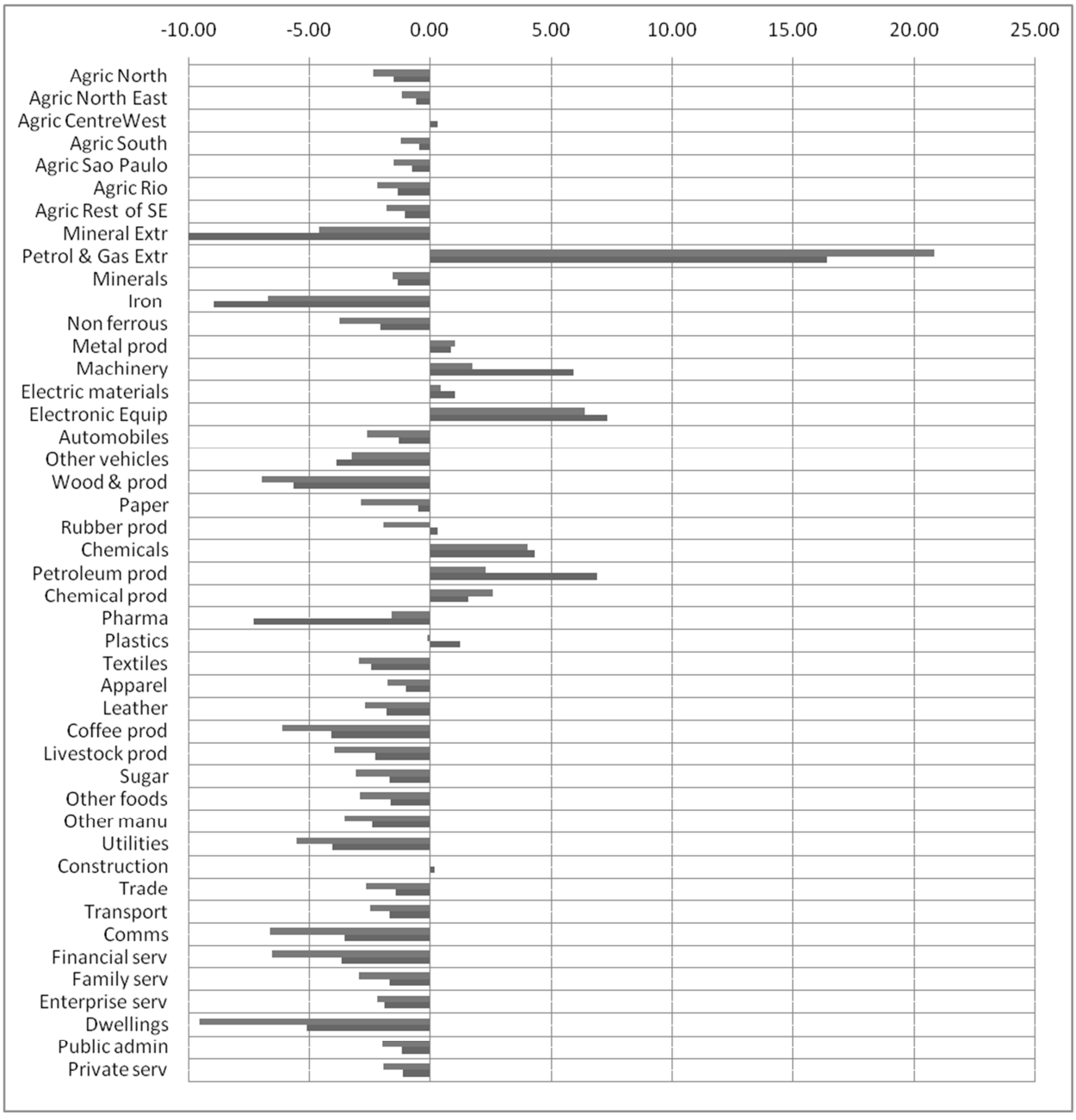
	LABOUR		CAPITAL		LAND	
	X-shock	X&M shock	X-shock	X&M shock	X-shock	X&M shock
Agric North	-1.05	-0.64	-9.51	-6.45	-9.51	-6.45
Agric North East	-0.42	-0.24	-5.48	-2.45	-5.48	-2.45
Agric CentreWest	-1.10	-0.60	6.37	5.88	6.37	5.88
Agric South	-1.25	-0.69	-1.01	1.04	-1.01	1.04
Agric Sao Paulo	-1.19	-0.70	-3.37	-1.12	-3.37	-1.12
Agric Rio	-1.01	-0.55	-8.69	-5.66	-8.69	-5.66
Agric Rest of SE	-0.88	-0.55	-6.97	-3.70	-6.97	-3.70
Mineral Extr	-1.88	-1.13	-5.38	-19.72		
Petrol & Gas Extr	-2.13	-1.18	32.76	25.24		
Minerals	-1.46	-0.86	-1.60	-1.78		
Iron	-1.82	-1.09	-8.25	-11.41		
Non ferrous	-1.82	-1.08	-4.47	-2.40		
Metal prod	-1.81	-1.06	3.84	2.77		
Machinery	-1.99	-1.16	8.82	19.74		
Electric materials	-1.94	-1.14	3.47	3.85		
Electronic Equip	-1.95	-1.15	19.70	20.93		
Automobiles	-2.15	-1.27	-5.19	-1.37		
Other vehicles	-2.13	-1.25	-5.98	-10.19		
Wood & prod	-1.28	-0.74	-12.61	-10.58		
Paper	-1.89	-1.11	-3.66	0.00		
Rubber prod	-2.07	-1.21	-1.75	2.28		
Chemicals	-1.78	-1.04	6.24	6.37		
Petroleum prod	-2.10	-1.17	4.10	10.26		
Chemical prod	-1.92	-1.13	7.33	4.42		
Pharma	-1.96	-1.15	-1.32	-12.15		
Plastics	-1.55	-0.91	2.79	5.53		
Textiles	-1.35	-0.78	-4.77	-4.28		
Apparel	-0.97	-0.56	-7.15	-4.23		
Leather	-1.00	-0.57	-11.09	-8.07		
Coffee prod	-1.36	-0.80	-12.77	-8.81		
Livestock prod	-1.35	-0.78	-7.77	-4.46		
Sugar	-1.36	-0.79	-3.89	-2.09		
Other foods	-1.34	-0.76	-4.57	-2.53		
Other manu	-1.64	-0.96	-5.69	-4.04		
Utilities	-1.90	-1.11	-6.45	-4.79		
Construction	-1.19	-0.70	1.22	1.16		
Trade	-1.58	-0.92	-4.42	-2.26		
Transport	-1.90	-1.11	-3.50	-2.72		
Comms	-1.90	-1.10	-8.05	-4.32		
Financial serv	-2.18	-1.27	-10.68	-5.97		
Family serv	-1.52	-0.88	-8.31	-4.69		
Enterprise serv	-1.89	-1.10	-2.89	-3.67		
Dwellings	-1.61	-0.93	-9.86	-5.28		
Public admin	-2.03	-1.18	-1.68	-1.23		
Private serv	-1.69	-0.98	-8.68	-4.82		

Source: simulation results.

The extent to which activities seek to increase or decrease the employment of primary inputs in aggregate depends upon the interaction of the average prices received for outputs and paid for (aggregate) intermediate inputs after paying any taxes on production and/or factors used in production. In terms of the model used these interactions determine the 'price of value added', which simply defines the amount available to pay primary inputs after meeting all other costs. The impacts on the price of value added by sector are illustrated in Figure 6.

What emerges is a pattern of incentives to restructure the mix of activities in the economy following the changes in export and import volumes. Overwhelmingly the expanding activities are manufacturing activities and among the manufacturing activities those seeking to expand are those that are typically more natural resource intensive.

Figure 6. Price of Value Added (% Change)



Source: simulation results.

6. Concluding Comments

In this paper, we examined the impact of the trade shock associated with the Great recession on labour and household income in Brazil. The implications of export and import volume shocks on the Brazilian economy turn out to be complex and depend critically upon assumptions about how trade commodity prices change and how much flexibility domestic agents are assumed to possess in response to relative price changes.

For the simulations presented in this paper, the responses available to domestic activities were assumed to be limited. The assumption of a short run adjustment period meant that capital and land use were fixed by activity and hence the majority of activity level response would be through the labour market. The responses available to labour types were also constrained: for higher skilled labour the choices were limited to reductions in wage rates that could to some extent be mitigated by migrating to regions wherein the corresponding wage rates were falling by (relatively) less, but for lower skilled labour types there was not offsetting options since they were price takes at fixed real wage rates.

Our findings indicate that – notwithstanding the negative trade shock - average returns to land and capital could increase in some regions. Overwhelmingly this was a consequence of the expansion of export demand for the characteristic commodities of certain activities. Since the patterns of ownership of capital and land will vary across the economy this indicates that there will be gainers and losers amongst the households that own land and capital, even if the average income from land and capital increase.

The results also suggest that a large proportion of the adjustment costs have to be borne by labour, with all labour types typically losing out. The more highly skilled labour types can ameliorate the losses but the lesser skilled labour types cannot and hence bear a disproportionate amount of the adjustment costs.

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Annexes

Annex 1. Database Accounts

Commodities		Activities		Factors		Factors	
cCana	Sugar Cane	aAgnorth	Agriculture North	fvlownorth	Very low wages North	fvlowrseast	Very low wages Rest of South East
cSoya	Soybean	aAgneast	Agriculture North East	flownorth	Low wages North	flowrseast	Low wages Rest of South East
cOagr	Other agriculture	aAgcwest	Agriculture CentreWest	fmednorth	Medium wages North	fmedrseast	Medium wages Rest of South East
cLstoc	Livestock	aAgsouth	Agriculture South	fhighnorth	High wages North	fhighrseast	High wages Rest of South East
cMinex	Mineral Extraction	aAgspaulo	Agriculture Sao Paulo	fvhighnorth	Very high wages North	fvhighrseast	Very high wages Rest of South East
CPGex	Petrol and Gas Extraction	aAgriojan	Agriculture Rio Janeiro	fcapnorth	Capital North	fcaprseast	Capital Rest of South East
cNmetex	Non metallic minerals	aAgrseast	Agriculture Rest of South East	flandnorth	Land North	flandrseast	Land Rest of South East
cIron	Iron	aMinex	Mineral Extraction	fvlowneast	Very low wages North East		
cNfer	Non ferrous metals	aPGex	Petrol and Gas Extraction	flowneast	Low wages North East		
cOmet	Other metal products	aNmetex	Non Metallic Minerals	fmedneast	Medium wages North East	**Households**	
cMach	Machinery	aIron	Iron	fhighneast	High wages North East	hnorth	Household North
cEmat	Electric materials	aNfer	Non ferrous metals	fvhighneast	Very high wages North East	hneast	Household North East
cEquip	Electronic Equipment	aOmet	Other metal products	fcapneast	Capital North East	hcwest	Household CentreWest
cAuto	Automobiles	aMach	Machinery	flandneast	Land North East	hsouth	Household South
cOveh	Other vehicles and spare parts	aEmat	Electric materials	fvlowcwest	Very low wages CentreWest	hspaulo	Household Sao Paulo
cFurn	Wood and furniture	aEquip	Electronic equipments	flowcwest	Low wages CentreWest	hriojan	Household Rio Janeiro
cPap	Paper and graphic	aAuto	Automobiles	fmedcwest	Medium wages CentreWest	hrseast	Household Rest of South East
cRub	Rubber products	aOveh	Other vehicles and spare parts	fhighcwest	High wages CentreWest		
cChem	Chemical elements	aFurn	Wood and furniture	fvhighcwest	Very high wages CentreWest		
cPetro	Refined petrol products	aPap	Paper and graphic	fcapcwest	Capital CentreWest	**Others**	
cOchem	Other chemical products	aRub	Rubber products	flandcwest	Land CentreWest	imptax	Import duties

Commodities		Activities		Factors		Factors	
cPharm	Pharmaceuticals	aChem	Chemical elements	fvlowsouth	Very low wages South	exptax	Export tax
cPlas	Plastics	aPetro	Refined petrol products	flowsouth	Low wages South	saltax	Sales Tax
cText	Textiles	aOchem	Other chemical products	fmedsouth	Medium wages South	ectax	Excise duty
cApp	Apparel	aPharm	Pharmaceuticals	fhighsouth	High wages South	indtax	Production taxes
cLeath	Leather products	aPlas	Plastics	fvhighsouth	Very high wages South	indsub	Production subsidies
cCoff	Processed coffee products	aText	Textiles	fcapsouth	Capital South	dirtax	Direct income taxes
cLprod	Livestock products	aApp	Apparel	flandsouth	Land South	facttax	Factor taxes
cSug	Sugar	aLeath	Leather products	fvlowspaulo	Very low wages Sao Paulo	Othtax	Other taxes
cOfd	Other food products	aCoff	Processed coffee products	flowspaulo	Low wages Sao Paulo	Govt	Government
cOman	Other manufacturing	aLprod	Livestock products	fmedspaulo	Medium wages Sao Paulo	i_s	Investment and savings
cUtil	Public Utilities	aSug	Sugar	fhighspaulo	High wages Sao Paulo	dstoc	Stock changes
cCons	Civil construction	aOfd	Other food products	fvhighspaulo	Very high wages Sao Paulo	row	Rest of the World
cTrad	Trade	aOman	Other manufacturing	fcapspaulo	Capital Sao Paulo	total	Totals
cTran	Transport	aUtil	Public Utilities	flandspaulo	Land Sao Paulo		
cComm	Communications	aCons	Civil construction	fvlowriojan	Very low wages Rio Janeiro		
cFser	Financial services	aTrad	Trade	flowriojan	Low wages Rio Janeiro		
cSfam	Services to families	aTran	Transport	fmedriojan	Medium wages Rio Janeiro		
cSent	Services to enterprises	aComm	Communications	fhighriojan	High wages Rio Janeiro		
cDwell	Dwellings	aFser	Financial services	fvhighriojan	Very high wages Rio Janeiro		
cSpub	Public administration	aSfam	Services to families	fcapriojan	Capital Rio Janeiro		
cSpriv	Non mercantile private services	aSent	Services to enterprises	flandriojan	Land Rio Janeiro		
		aDwell	Dwellings				
		aSpub	Public administration				

Annex 2. Model Overview

The model used in this study is a development of the STAGE (Static Applied General Equilibrium) model (McDonald, 2007) called STAGE_LAB. STAGE_LAB is a member of the STAGE suite of single country computable general equilibrium models. Conceptually, it falls into the class of models that follow the approach described by (Derivis, de Melo, & Robinson, 1982) and the models developed by (Robinson, Kilkenny, & Hanson, 1990) and (Kilkenny, 1991). At the core of the suite is the basic STAGE model customised to the setting/economic environment being explored in this paper.

A. Behavioural Relationships

Households are assumed to choose the bundles of commodities they consume so as to maximise utility where the utility function is Stone-Geary. The households choose their consumption bundles from a set of 'composite' commodities that are aggregates of domestically produced and imported commodities. These 'composite' commodities are formed as Constant Elasticity of Substitution (CES) aggregates that embody the presumption that domestically produced and imported commodities are imperfect substitutes. The optimal ratios of imported and domestic commodities are determined by the relative prices of the imported and domestic commodities. This is the so-called Armington 'insight'(Armington, 1969), which has the advantage of rendering the model practical by avoiding the extreme specialisation and price fluctuations associated with other trade assumptions. In this model the country is assumed to be a price taker for all imported commodities.

Domestic production uses a multi-stage production process (see below). The vector of commodities demanded is determined by the domestic demand for domestically produced commodities and export demand for domestically produced commodities. Using the assumption of imperfect transformation between domestic demand and export demand, in the form of a Constant Elasticity of Transformation (CET) function, the optimal distribution of domestically produced commodities between the domestic and export markets is determined by the relative prices on the alternative markets. The model can be specified as a small country, i.e., price taker, on all export markets, or selected export commodities can be deemed to face downward sloping export demand functions, i.e., a large country assumption.

The other behavioural relationships in the model are generally linear. A special feature of the model is that all the tax rates are declared as variables that can adjust endogenously to satisfy fiscal policy constraints. Similar adjustment mechanisms are available for a number of key parameters, e.g., savings rates for households and incorporated business enterprise and inter-institutional transfers.

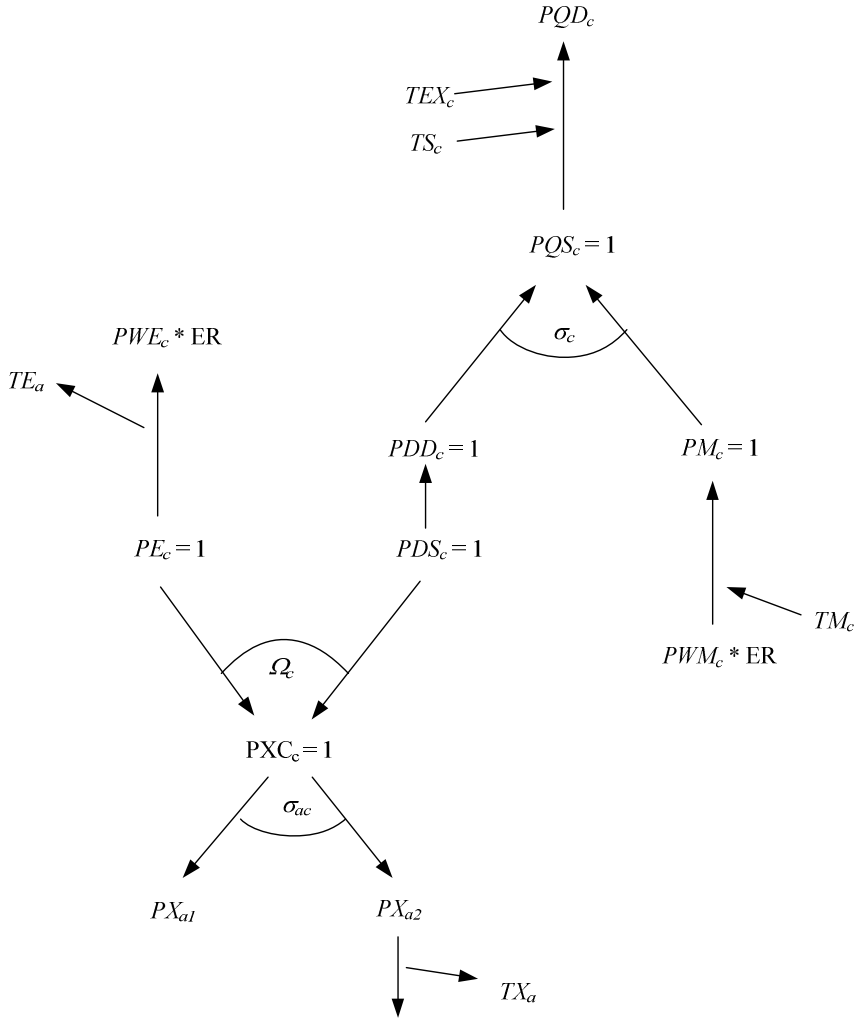
B. Price and Quantity Relationships

Figure A.1 and Figure A.2 provide detail on the interrelationships between the prices and quantities for commodities and activities. The supply prices of the composite commodities (PQS_c) are defined as the weighted averages of the domestically produced commodities that are consumed domestically (PD_c) and the domestic prices of imported commodities (PM_c), which are defined as the products of the world prices of commodities (PWM_c) and the exchange rate (ER) uplifted by *ad valorem* import duties (TM_c). These weights are updated in the model through first order conditions for optima. The average prices exclude sales taxes, and hence must be uplifted by (*ad valorem*) sales taxes (TS_c) to

reflect the composite consumer price (PQD_c).[19] The producer prices of commodities (PXC_c) are similarly defined as the weighted averages of the prices received for domestically produced commodities sold on domestic and export (PE_c) markets. These weights are updated in the model through first order conditions for optima. The prices received on the export market are defined as the products of the world price of exports (PWE_c) and the exchange rate (ER) less any exports duties due, which are defined by *ad valorem* export duty rates (TE_c).

The average price per unit of output received by an activity (PX_a) is defined as the weighted average of the domestic producer prices, where the weights are constant. After paying indirect/production/output taxes (TX_a), this is divided between payments to aggregate value added (PVA_a), i.e., the amount available to pay primary inputs, and aggregate intermediate inputs ($PINT_a$). Total payments for intermediate inputs per unit of aggregate intermediate input are defined as the weighted sums of the prices of the inputs (PQD_c).

Figure A.1: Price Relationships in the STAGE Model

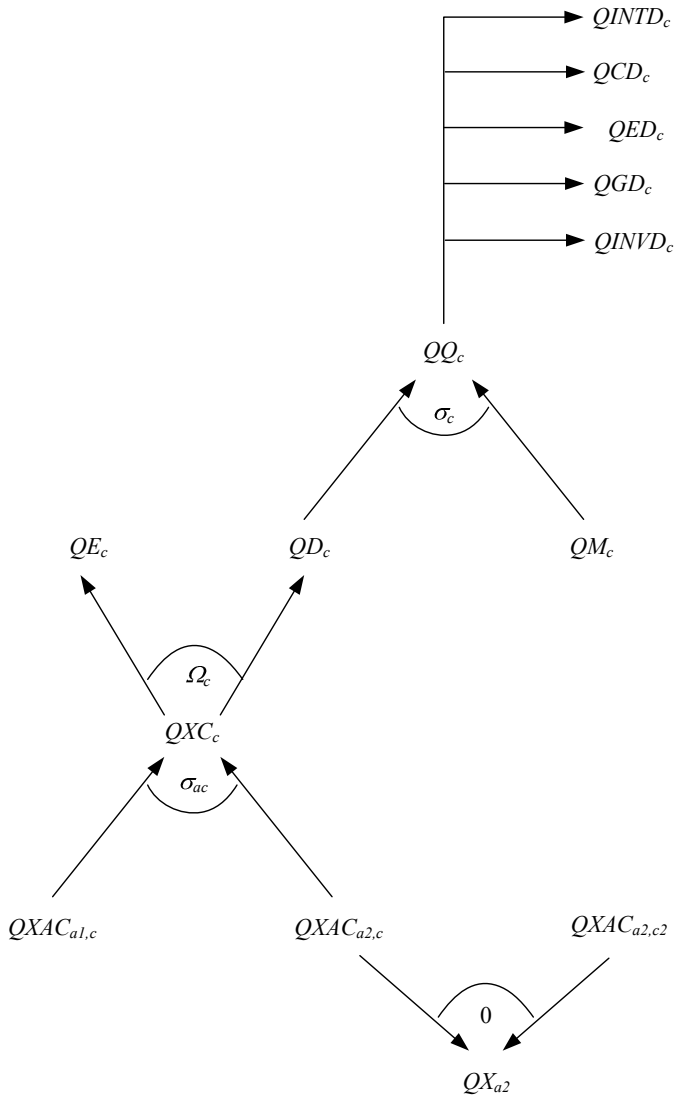


Total demands for the composite commodities, QQ_c, consist of demands for intermediate inputs, $QINTD_c$, consumption by households, QCD_c, incorporated business

[19] For simplicity only one tax on domestic commodity sales is included in this figure.

enterprises[20], QED_c, and government, QGD_c, gross fixed capital formation, $QINVD_c$, and stock changes, $dstocconst_c$. Supplies from domestic producers, QDD_c, plus imports, QM_c, meet these demands; equilibrium conditions ensure that the total supplies and demands for all composite commodities equate. Commodities are delivered to both the domestic and export, QE_c, markets subject to equilibrium conditions that require all domestic commodity production, QXC_c, to be either domestically consumed or exported.

Figure A.2: Quantity Relationships in the STAGE Model



The presence of multi product activities means that domestically produced commodities can come from multiple activities, i.e., the total production of a commodity is defined as the sum of the amount of that commodity produced by each activity. Hence the domestic production of a commodity (*QXC*) is a CES aggregate of the quantities of that commodity produced by a number of different activities (*QXAC*), which are produced by each activity in activity specific fixed proportions, i.e., the output of *QXAC* is a Leontief (fixed proportions) aggregate of the output of each activity (*QX*).

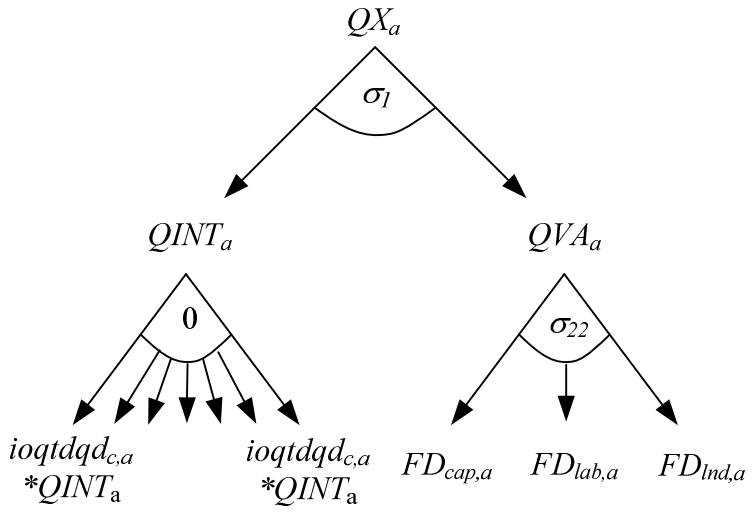
[20] Incorporated business enterprises are institutional accounts. An enterprise is defined as a legal or social entity that engages in economic activities and transactions in its own right.

C. Production Nesting Structure and Labour Types

Production relationships by activities are defined by a series of nested Constant Elasticity of Substitution (CES) production functions.[21] Mathematically the limit on the number of levels of nests is only constrained by the number of different factor types included in the database. However there are additional limits imposed by economic meaningfulness and the availability of empirical data that allow for the inclusion of information (elasticities of substitution) about the possibilities for substitution between and within sub groups of factors. The illustrations below are for the four level production nest, in quantity terms, used for this study. To facilitate understanding there are four figures for quantities and four for prices.

Figure A.3 illustrates the top two levels of the production nest. At the top level activity output (*QX*) is a CES aggregate of the quantities of aggregate intermediate inputs (*QINT*) and value added (*QVA*). Aggregate intermediate inputs are a Leontief aggregate of the (individual) intermediate inputs. Aggregate value added is more complex: it is a CES aggregate of the quantities of 'primary' inputs demanded by each activity (*FD*), where the primary inputs can be natural factors – types of labour, capital and land that exist – and aggregate factors that are aggregates of natural factors and/or other aggregate factors. Any factor at the end of any branch in Figures A.5, A.7 and A.9 is by definition a natural factor, i.e., it is not an aggregate, whereas all the intermediate 'factors' are CES aggregates. Thus the terms *FD* can refer to both 'natural' factors and aggregates. In the model the set *ff* is defined as the set of all natural and aggregated factors while the set *f*, a sub set of *ff*, is defined as the set of all natural factors; other sub sets of *ff* define the level of each factor – natural or aggregate – in the nesting structure. The members of the sets *ff* and *f* are detailed in Table A.1.

Figure A.3: Production Relationships: Top Two Levels (Quantities)



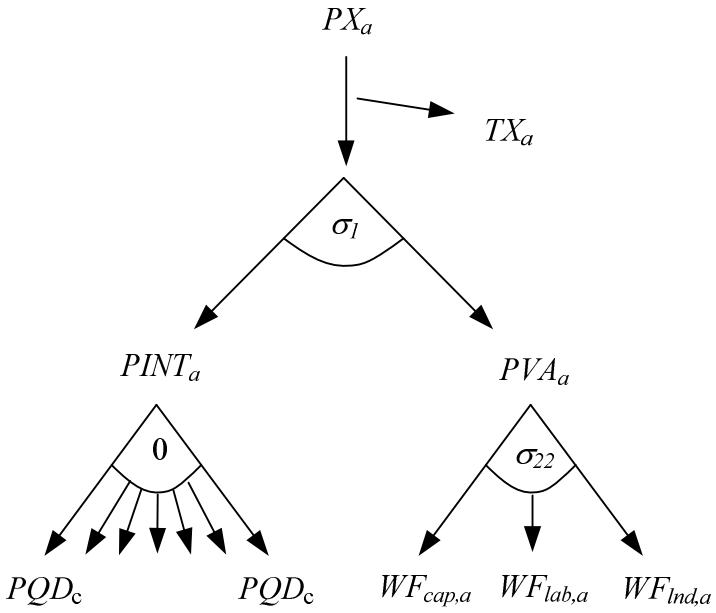
Starting from the top of the value added nests in Table A.3, aggregate value added is an aggregate of three aggregate factors – land (lnd), capital (cap) and labour (lab). This reflects the fact that the database records transactions for 7 types of land and capital and 35 types of labour. The aggregates for land and capital are both formed in one extra nest –

[21] (Perroni & Rutherford, 1995) demonstrate that nested CES function can approximate any flexible functional form, e.g., translog.

see Figures A.5 and A.7 – where land and capital differentiated by the regions of Brazil in which they are employed are aggregated using CES technology.

The corresponding levels of the price system are illustrated in Figure A.4. Several points justify emphasis. First, the output price (*PX*) is expressed inclusive of production taxes (*TX*) but the relevant price for the determination of the optimum quantities of aggregate intermediates and value added is net of production taxes. Second, the prices for individual intermediate inputs are the purchaser prices for commodities in the economy. And third, the prices for aggregate intermediates (*PINT*) and value added (*PVA*) are constructs; they have no existence in reality rather they are simple intermediate steps used by the model to determine the optimum quantities of natural inputs used in the production processes of activities. An important point to note about these prices, as with all the price constructs, is that they cannot be subject to price wedges that are due to tax, or similar, instruments.

Figure A.4: Production Relationships: Top two Levels (Prices)



Since land cannot be moved it is reasonable to assume that the quantities of land in each region are fixed, at least over a substantial period of time, although of course more land may be brought within the production boundary in a relative short time, e.g., through land clearance, or existing land may be made more productive, e.g., through drainage. Even if, for simplicity, it is assumed that the supplies of productive services flowing from the stocks of land in each region are fixed this does not preclude substitution of land in one region for another by any activity except in so far as the land using activities are region specific. In this database (SAM) the agricultural activities are specified as region specific activities that produce multiple outputs (commodities) and are the only users of land as a productive input in their regions. Therefore there are no substitution possibilities between the different types of land: the effective elasticities of substitution for the aggregate land factors for each activity (σ33) are all therefore equal to zero. Strictly therefore this nest for land, see Figures A.5 and A.6, could be avoided by entering each of land types as a separate factor in the aggregate value added function with a common elasticity of substitution across all land types and aggregate capital and labour; the choice to include a land nest has no impact on the performance of the model.

In the case where the nest has zero substitutability the aggregate price ($WF_{lnd,a}$) is a simple constant weighted sum of the component prices, e.g., $WF_{n4,a}$.

Figure A.5: Production Relationships: Aggregate Land (Quantities)

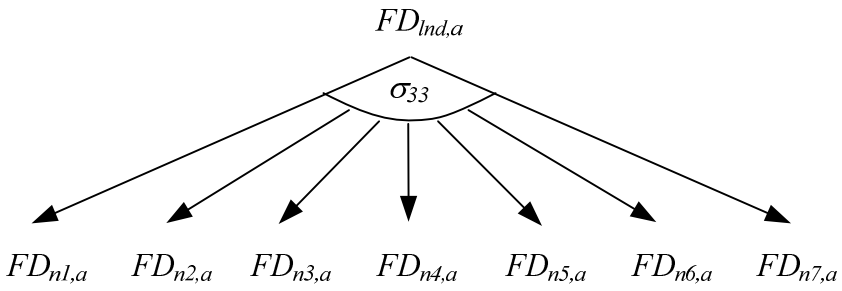
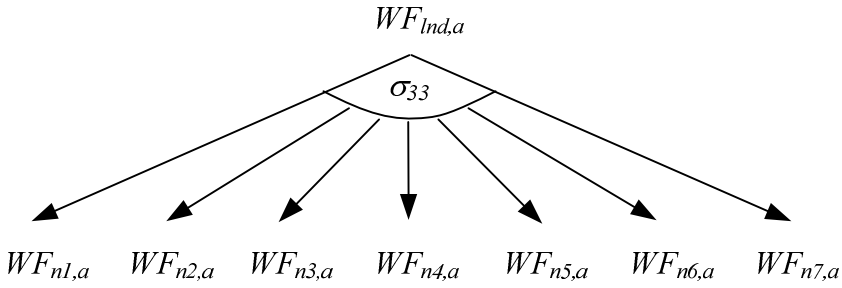
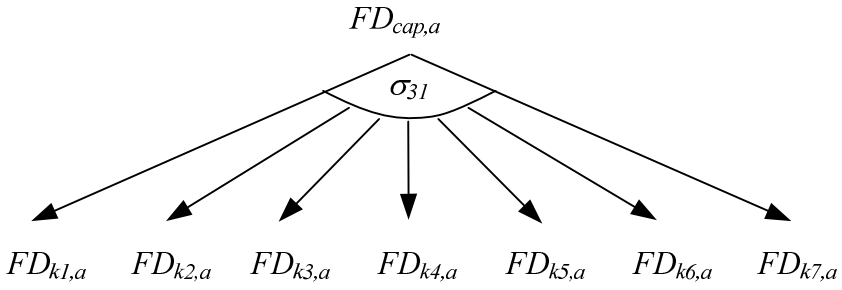


Figure A.6: Production Relationships: Aggregate Land (Prices)



Unlike land, capital is not region specific since capital for all regions is potentially used by all activities. Thus there are substitution possibilities between types of capital and therefore the elasticities of substitution (σ_{31}) are all positive and are activity specific, and the aggregate is a construct formed as an index of the natural types of capital.

Figure A.7: Production Relationships: Aggregate Capital (Quantities)



In the case where the nest has imperfect substitutability the aggregate price ($WF_{cap,a}$) is a weighted sum of the component prices, e.g., $WF_{k4,a}$, where the weights vary with the optimal mix of capital across the different types of capital. Consequently changes in the demand for different (natural) types of capital will causes changes in the prices of those

types of capital and in the price of the aggregate; these will be passed up to the next level of the nest as changes in the price of the capital aggregate.

Figure A.8: Production Relationship: Aggregate Capital (Prices)

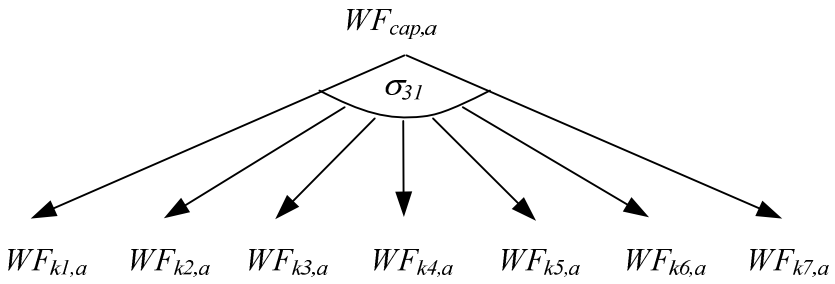


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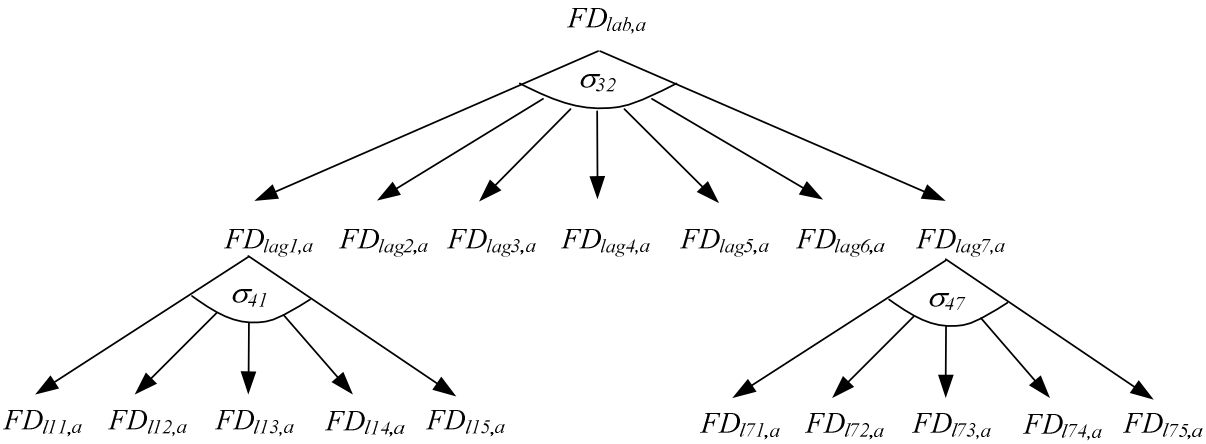
Table A.1: Natural and Aggregate Factors

	Aggregates	Natural Factors	Aggregates	Natural Factors
Aggregate labour	Aggregate labour North	Labour V low wages North	Aggregate land	Land North
		Labour Low wages North		Land North East
		Labour Med wages North		Land CentreWest
		Labour High wages North		Land South
		Labour V high wages North		Land Sao Paulo
	Aggregate labour North East	Labour V low wages North East		Land Rio Janeiro
		Labour Low wages North East		Land Rest of South East
		Labour Med wages North East		
		Labour High wages North East	Aggregate capital	Capital North
		Labour V high wages North East		Capital North East
	Aggregate labour CentreWest	Labour V low wages CentreWest		Capital CentreWest
		Labour Low wages CentreWest		Capital South
		Labour Med wages CentreWest		Capital Sao Paulo
		Labour High wages CentreWest		Capital Rio Janeiro
		Labour V high wages CentreWest		Capital Rest of South East
	Aggregate labour South	Labour V low wages South		
		Labour Low wages South		
		Labour Med wages South		
		Labour High wages South		
		Labour V high wages South		
	Aggregate labour Sao Paulo	Labour V low wages Sao Paulo		
		Labour Low wages Sao Paulo		
		Labour Med wages Sao Paulo		
		Labour High wages Sao Paulo		
		Labour V high wages Sao Paulo		
	Aggregate labour Rio Janeiro	Labour V low wages Rio Janeiro		
		Labour Low wages Rio Janeiro		
		Labour Med wages Rio Janeiro		
		Labour High wages Rio Janeiro		
		Labour V high wages Rio Janeiro		
	Aggregate labour Rest of S East	Labour V low wages Rest of South East		
		Labour Low wages Rest of South East		
		Labour Med wages Rest of South East		
		Labour High wages Rest of South East		
		Labour V high wages Rest of South East		

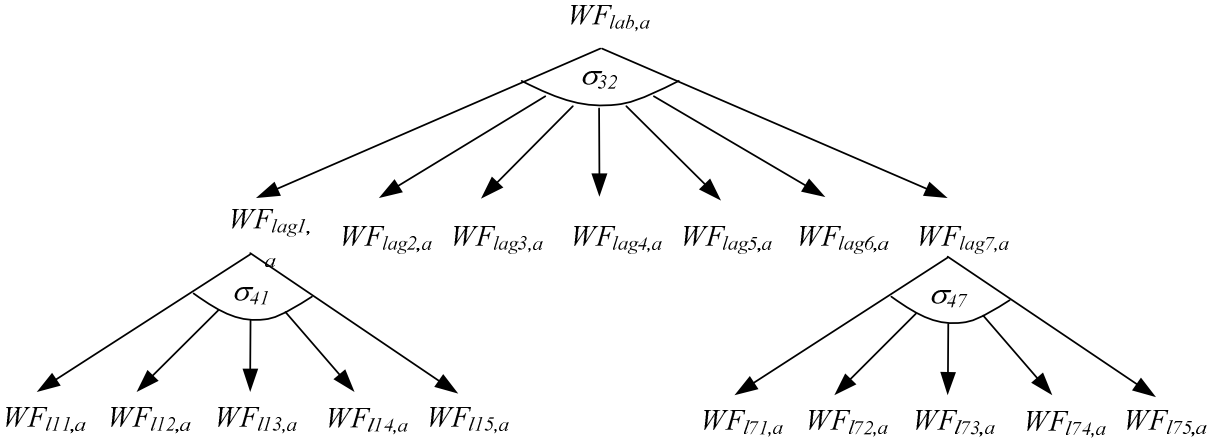
The labour nesting is more complex because it involves two levels of nesting. At the bottom of the nesting structure are 35 different types of natural labour ($FD_{lij,a}$); each type of labour is distinguished by which of seven the regions (i) within which it is currently employed and five levels of wages rates (j), where wage rates are taken as proxies for levels of skill. The implicit behavioural assumption is that employers choose from the pool of differently skilled workers within a region according to the relative prices of the different types of labour within the region, which process identifies the aggregate quantities of labour employed within each region by each activity. If the average price of labour in a region rises – relative to the price in other regions – then it is assumed that activities will substitute between labour from the different regions according to relative prices. There is again an implicit presumption; as activities change the mix of aggregate labour types so implicitly they are reallocating productivity activities across regions.

Figure A.9: Production Relationships: Labour (Quantities)



The nesting structure in quantity terms for labour is illustrated in Figure A.9 and for prices in Figure A.10, where the bottom level of the nesting is only fully articulated for two regions. The construct prices, $WF_{lag*,a}$ have no real world counterpart and therefore cannot be subjected to changes in tax instrument. But the bottom level prices can be subjected to tax and the model allows for all natural factors to be subjected to factor use taxes that are activity and factor specific; these taxes obviously enter into the first order conditions for optimal input mixes.

Figure A.10: Production Relationships: Labour (Prices)



The advantage of using such a nesting structure is that it avoids making the assumption that all natural factors are equally substitutable in the generation of value added. In the case illustrated by Figures A.1 to A.10 the implicit presumption is that different types of labour are not equally substitutable but that aggregate labour, capital and land are equally substitutable. For instance the level 3 labour aggregates, $FD_{lag,a}$, may be defined as the aggregate labour employed by an activity class in a specific region, which is made up of seven types of labour that have different sets of skills but can only be employed in the specific region. However the activity class may choose to 'substitute' labour from different regions by altering the balance between production taking place in different regions.

This highlights an important consideration. The adoption of a nesting structure carries with it the presumption that factor markets are segmented, i.e., while unskilled labour from a region can be part of that region's aggregate labour factor, unskilled labour from another region cannot. Implicit to this structure therefore is the presumption that labour cannot migrate between regions, whereas in reality there are large amounts of evidence that people are prepared to migrate in search of improved employment opportunities. To address this consideration STAGE_LAB includes a series of migration functions that allow net migration of factors of production between the sub nests of the production structure, e.g., skilled labour can migrate between different regions in response to employment opportunities. The incentives to migrate are determined by the changes in the relative wages received by the factors in different sub nests.

Until now it has been assumed that labour supplies are fixed. However STAGE_LAB allows for the possibility of unemployment for each and every natural factor. This is achieved by defining the supply of each factor by reference to current total demand PLUS the stock of the factor currently unemployed. In the case of labour, if there is current unemployment for a class of labour, e.g., unskilled, the real wage of that class is fixed until all the stock of unemployed unskilled workers have been absorbed by the labour market and thereafter the real wage of the factor is flexible.[1] This form of

[1] In terms of the model this requires that the model operates with one regime when there is unemployment and another regime when there is full employment. This regime switching is achieved by specifying the model as mixed complementarity problem (MCP). The variant used here generates a two segments labour supply function – horizontal until full employment and then vertical – but more complex options are possible, e.g., three

regime switching is attractive since it increases the realism with which the labour markets are modelled, but it does have some implications for the modelling of labour migration. Given that labour migration decisions depend on changes in relative wage rates there can only be *net* migration when a factor within a migration pool is fully employed, since only then can relative wages change.

D. Migration Relationships

One problem the presumption that factor markets are segmented is that it prohibits movement of factors between the sub nests. This restriction makes economic and logical sense when it imposes the condition that inherently different factors cannot be transformed from one format to another, e.g., labour cannot be transformed capital (except through production processes and investment). On the other hand there is no binding reason to suppose that skilled labour cannot provide unskilled labour services relatively easily, although the opposite transformation is likely to be time and resource consuming. Even more compelling is the argument that labour of the same skill type located in different regions can substitute for the same labour type in another regions, albeit migration is not costless and there are limitations on the extent of relocations that are likely to take place for a range of reasons, e.g., personal preferences and family commitments. When migration is from one physical location to another it accords with normal usage of the terminology, but in this instance the term migration is adopted to embrace all economically induced transitions form one labour market segment to another.

In order to allow for these migration possibilities the model includes a supply function with constant elasticity for each factor type. If the relative wage of the factor in a sub nest increases/decreases the supply of that factor to a sub nest increases/decreases subject to the condition that the total supply of that factor type in the economy is fixed: the resultant migrations represent a partial adjustment in response to changes in relative wages and combined with the constraint ensure market clearing without any increase in labour supply. The degrees of mobility are controlled by the supply elasticities, which can vary for each and every factor, e.g., unskilled labour in one region may be more or less mobile that unskilled labour in other regions. In practice this version of the model operates a pooling system; the labour supply functions either supply or demand labour to/from a series of pools rather than engage in bilateral migration between sub nests; thus only net migration is modelled. Full bi lateral tracking of labour migration could be readily achieved, but would require the imposition of many more supply elasticities for which there is limited information. The choice of the pooling mechanism is accordingly driven by the decision to achieve a balance between detail and the imposition of exogenous information that has limited empirical basis.

segments – horizontal until unemployment rate fall below some level, upward sloping until full employment and thereafter vertical.

$$WFMIG_{f,mig} = \left(\frac{\sum_a WF_f * WFDIST_{f,a} * FD_{f,a}}{\sum_a FD_{f,a}} \right) \Big/ AVGWF_{mig} \; . \qquad \text{(MG1)}$$

$$FS_f = FS0_f * \left(\sum_{mig} \frac{WFMIG_{f,mig}}{WFMIG_{f,mig}} \right)^{etamig_f} \; . \qquad \text{(MG2)}$$

$$\sum_{f\$map\_mig\_f_{mig,f}} FS_f = \sum_{f\$map\_mig\_f_{mig,f}} FS0_f \; . \qquad \text{(MG3)}$$

Migration Possibilities and Elasticities

The implementation of these migration functions requires the specification of first the migration possibilities, i.e., the factors that can migrate and other factor categories to which they can migrate, and supply elasticities for the factors that can migrate.

The migration possibilities are defined by the mapping set, map_mig_f(mig,f), that defines the factors, f, that can migrate to each pool, mig. In this configuration it is assumed that labour factors can change the region within which they are employed, i.e., they can relocate/migrate to another region, but they cannot change their skill category. Thus high skilled labour can relocate from one region to another but only as high skilled labour. But note the model does not track bilateral migration flows; rather labour that chooses to exit a region if that regions relative wage falls and enters a 'pool' from which regions whose relative wage has risen draws labour. The current migration possibility mapping is recorded in the workbook as 'migrat!N4:O39'. The migration elasticities are recorded in the worksheet 'migelast'.

Annex 3. Commodity Elasticities

	sigma	omega	sigmaxc
Sugar Cane	3.75	2	2.5
Soybean	3.75	2.5	2.5
Other agriculture	3.75	2.5	2.5
Livestock	3.75	2.5	2.5
Mineral Extraction	3.75	2.5	1.5
Petrol and Gas Extraction	3.75	2.5	1.5
Non Metallic Metals	3.75	2.5	1.5
Iron	3.75	2.5	1.5
Non ferrous metals	3.75	2.5	1.5
Other metals	2.25	2	1.5
Machinery	2.25	2	1.5
Electric materials	2.25	2	1.5
Electronic equipments	2.25	2	1.5
Automobiles	2.25	2	1.5
Other vehicles and spare parts	2.25	2	1.5
Wood and furniture	2.25	2	1.5
Paper and graphic	2.25	2	1.5
Rubber products	2.25	2	1.5
Chemical elements	2.25	2	1.5
Refined petrol products	2.25	2	1.5
Other chemical products	2.25	2	1.5
Pharmaceuticals	2.25	2	1.5
Plastics	3	2	1.5
Textiles	3	2	1.5
Apparel	3	2	1.5
Leather products	3	2	1.5
Processed coffee products	3	2	1.5
Livestock products	3	2	1.5
Sugar	3	2	1.5
Other food products	3	2	1.5
Other manufacturing	3	2	1.5

	sigma	omega	sigmaxc
Public Utilities	3	2	1.5
Civil construction	1.2	0.9	1.5
Trade	1.2	0.9	1.5
Transport	1.2	0.9	1.5
Communications	1.2	0.9	1.5
Financial services	1.2	0.9	1.5
Services to families	1.2	0.9	1.5
Services to enterprises	1.2	0.9	1.5
Dwellings	1.2	0.9	1.5
Public administration	1.2	0.9	1.5
Non mercantile private services	1.2	0.9	1.5

Annex 4. Activity Elasticities

	sigmax	sigmava	flnd	fcap	flab	flnorth	flneast	flcwest	flsouth	flspaulo	flriojan	flrseast
Agriculture North	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Agriculture North East	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Agriculture CentreWest	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Agriculture South	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Agriculture Sao Paulo	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Agriculture Rio Janeiro	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Agriculture Rest of South East	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Mineral Extraction	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Petrol and Gas Extraction	0.675	0.9	1.5	1.5	1.6	2	2	2	2	2	2	2
Non Metallic Metals	0.675	0.9	1.5	1.5	1.6	2	2	2	2	2	2	2
Iron	0.675	0.9	1.5	1.5	1.6	2	2	2	2	2	2	2
Non ferrous metals	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Other metals	0.675	0.9	1.5	1.5	1.6	2	2	2	2	2	2	2
Machinery	0.45	0.6	1.5	1.5	0.9	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Electric materials	0.45	0.6	1.5	1.5	0.9	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Electronic equipments	0.45	0.6	1.5	1.5	0.9	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Automobiles	0.45	0.6	1.5	1.5	0.9	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Other vehicles and spare parts	0.45	0.6	1.5	1.5	0.9	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Wood and furniture	0.675	0.9	1.5	1.5	1.6	2	2	2	2	2	2	2
Paper and graphic	0.45	0.6	1.5	1.5	0.9	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Rubber products	0.45	0.6	1.5	1.5	0.9	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Chemical elements	0.675	0.9	1.5	1.5	1.6	2	2	2	2	2	2	2
Refined petrol products	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Other chemical products	0.675	0.9	1.5	1.5	1.6	2	2	2	2	2	2	2
Pharmaceuticals	0.45	0.6	1.5	1.5	0.9	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Plastics	0.45	0.6	1.5	1.5	0.9	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Textiles	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Apparel	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Leather products	0.675	0.9	1.5	1.5	1.6	2	2	2	2	2	2	2
Processed coffee products	0.675	0.9	1.5	1.5	1.6	2	2	2	2	2	2	2
Livestock products	0.675	0.9	1.5	1.5	1.6	2	2	2	2	2	2	2
Sugar	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Other food products	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Other manufacturing	0.675	0.9	1.5	1.5	1.6	2	2	2	2	2	2	2
Public Utilities	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Civil construction	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Trade	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Transport	0.675	0.9	1.5	1.5	1.6	2	2	2	2	2	2	2
Communications	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Financial services	0.45	0.6	1.5	1.5	0.9	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Services to families	0.675	0.9	1.5	1.5	1.6	2	2	2	2	2	2	2
Services to enterprises	0.675	0.9	1.5	1.5	1.6	2	2	2	2	2	2	2
Dwellings	0.9	1.2	1.5	1.5	2	3	3	3	3	3	3	3
Public administration	0.675	0.9	1.5	1.5	1.6	2	2	2	2	2	2	2
Non mercantile private services	0.675	0.9	1.5	1.5	1.6	2	2	2	2	2	2	2