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Trade and agricultural employment linkages in general equilibrium modelling

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Abstract

Trade negotiators are frequently concerned about the possible negative effects of trade liberalisation on employment in specific sectors. The agricultural sector in developing countries has characteristics that make it different from industrial or service sectors. These characteristics are an informal labour force, low productivity, absence of regulations and a tie to land. These features affect adjustment costs.

A global computable general equilibrium model, GTAP, is used to analyse employment and wage effects of trade liberalization in three developing countries — Indonesia, Bangladesh and Guatemala. The ability to fully utilize all resources, including labour, is important. The results highlight the advantage of a functioning and flexible labour market that can readily adjust to trade shocks.

JEL subject codes F13, Q17.

Key words: agriculture, trade, employment

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1 Introduction

The workforce in the agriculture sector in developing countries is often characterized by absence of regulations, low productivity, informality, and labour surplus. In contrast to manufacturing, agricultural production is tied to land, and the product tends to be quite substitutable from one exporter to the next. These facts have implications for the impact of trade and trade liberalization on agricultural employment and wages.

The absence of regulations implies that there are, effectively, no minimum wage or labour standards. This means that agricultural wages are often relatively flexible downwards as well as upwards.

In developing countries the agricultural sector employs about 29 per cent of the labour force – 757 million workers – and yet it produces only 10 per cent of the output (UNCTADstat).² Productivity is low because the labour is relatively unskilled and the amount of capital used with labour is small. The contribution of agriculture to economy-wide productivity gains is disproportionately low (UNCTAD, 2010).

Because of the informal nature of the sector, it frequently contains surplus labour. However, unemployment is not obvious because it is disguised. Workers are underemployed rather than unemployed. They would work more intensely or longer if there were demand for their products. Often, jobs in agriculture are low-quality jobs in terms of low payment and bad working conditions.

Finally, primary agricultural production is tied to land. For most types of production, the land can be switched from one crop to another. Thus, a fall in wheat prices does not mean that wheat producers become unemployed. Instead, they often can switch to another crop within a season. Producers of tree crops such as rubber and coffee are not so flexible.

There are several reasons to consider the link between trade and agricultural employment. Trade is important in agriculture. Over half of global production is exported – 52 per cent, compared with 28 per cent of goods and services (UNCTAD, 2011) – although with significant variation across products. In 2010 the value of agricultural trade constituted 9.2 per cent of world merchandise trade. Developing countries account for 38 per cent of world agricultural exports, an increase from 31 per cent in 2000, driven by increasing exports from Latin America. Agriculture as a source of export revenue is particularly important for many Latin American and sub-Saharan African countries, where agriculture often accounts for more than half of total export revenue (UNCTAD, 2011).

² Agriculture includes hunting, forestry, and fishing (corresponds to International Standard Industrial Classification, Rev.3, divisions 01–05).

Agriculture is one of the most distorted sectors. While tariffs on non-agricultural products have been reduced to an average of 3 per cent and 13 per cent in developed and developing countries, respectively, most favoured nation (MFN) tariffs on agricultural goods average 34 per cent and 25 per cent, respectively (chapter 2, this volume). In addition, agricultural subsidies contribute to the distortions.

Given the characteristics of agricultural trade, the purpose of this paper is to review the linkages between trade and employment using various modelling approaches. For trade policy analysis, three popular approaches are³:

- partial equilibrium models
- social accounting matrices and
- general equilibrium models.

Single-sector partial equilibrium models are inadequate because they do not capture the flow of labour from one sector to another. Social accounting matrices cover all sectors but lack behavioural equations. Computable general equilibrium (CGE) models combine intersectoral linkages and behavioural responses. However, their cost is loss of transparency and the need for more sophisticated programming. An inherent weakness of most CGE models to assess the effects of trade policy changes on employment is the closure of the model with respect to the labour market, assuming full employment and flexible wages.

This chapter discusses the three modelling approaches and their advantages as well as limitations to analyse the link between trade and employment in agriculture. By way of illustration we apply the well-known Global Trade Analysis Project (GTAP) CGE model to unilateral trade liberalization in three countries as well as to multilateral liberalization.⁴ Different labour market assumptions are tested. In particular, we are interested to know whether trade liberalization might lead to unemployment or falling wages in the agricultural sector. Adjustments in individual agricultural sectors are high, but overall employment effects in agriculture are relatively small.

2 Quantitative Models

2.1 *Partial equilibrium models*

Partial equilibrium models tend to focus on one or a small number of sectors. Their strengths are simplicity and transparency. If labour and other factors are assumed to be used in fixed proportions to output, a simple model consisting of three equations – for supply, demand, and net trade – can be used to show the employment effects of a trade shock. However, results from partial equilibrium models tend to overstate the positive or negative effects of a trade shock because the expansion of a sector appears to have

³ Gibson (2011) provides an overview of main methodologies that have been used to address the link between trade and employment.

⁴ The model is fully documented in Hertel and Tsigas (1996) and can be downloaded from <http://www.gtap.org>.

no consequences for other sectors, or, conversely, the contraction of a sector is not compensated for by increased employment elsewhere.

For example, consider a single market specifying demand (D), supply (S), exports (X), and imports (M) that respond to domestic prices (P_d). Without trade, the market clearing condition is that demand equals supply, $D=S$. With the opportunity to trade, however, production plus imports must equal consumption plus exports. If exports are a constant proportion of production, and domestic prices are linked to world prices, P_w , through a tariff, t , the system of equations can be written as:

$$D = f(P_d) \quad (1)$$

$$S = g(P_d) \quad (2)$$

$$X = h(S) \quad (3)$$

$$M = D - S + X \quad (4)$$

$$P_d = P_w + t \quad (5)$$

If labour is used in fixed proportions to production, it is clear that a reduction in the tariff will reduce domestic prices, production, and employment. In this specification the increase in imports does not proportionally displace labour because there is an increase in consumption. The relationship between production and imports in response to a change in tariffs is given by the elasticities of supply and demand. Nonetheless, labour dismissed from the sector is not employed elsewhere. Conversely, if there is an increase in demand for labour, there is no offsetting reduction in another sector. A trade-induced fall in output in a labour-intensive sector is seen as worse for employment than a similar fall in output in a capital-intensive sector.

Examples of partial equilibrium models are the Agriculture Trade Policy Simulation Model (ATPSM) and the Global Simulation Model (GSIM). The former, developed by the Food and Agriculture Organization (FAO) and the United Nations Conference on Trade and Development (UNCTAD), has been used, for example, by Peters and Vanzetti (2004) to analyse Doha Round proposals in World Trade Organization (WTO) agriculture negotiations. The model includes many agriculture-specific or relevant features such as domestic support, export subsidies, and tariff rate quotas, but it does not explicitly include employment. Vanzetti and Nikolić (chapter 7) use the GSIM model to analyse regional and unilateral trade policy changes for specific products. Employment effects are calculated in proportion to changes in output.

2.2 *Social accounting matrices*

An approach that takes account of cross-sector linkages is to use an input–output (IO) table that shows the backward and forward linkages between all sectors of the economy. The IO table shows sales from each sector to all others. Conversely, the cost of production in each sector is disaggregated into purchases from other sectors, including labour, capital, and other primary factors. These factors can be disaggregated into as many sectors as the data permit. Labour can be divided, for example, by occupation or

skills levels. With the inclusion of additional data such as savings and investment, IO tables can be enhanced to become so-called social accounting matrices (SAMs). These can be used to show the impact of a change in final demand – including exports, for example – on production and hence on the use of the various inputs, including labour. The key equation is:

$$X = AX + D \quad (6)$$

where X is a vector of output, A is a matrix of coefficients that describes the use of inputs used in the production of outputs in each sector, and D is final demand. Since D includes imports and exports as well as consumption, a change in imports can be seen to affect output and hence labour use. In this framework an increase in imports fully displaces domestic production, causing an increase in unemployment. Likewise, an increase in exports pulls surplus labour into employment.

SAMs have the advantage of transparency, a point emphasised by Ernst and Peters (2011) in a paper examining the Indonesian economy. Such models assume fixed coefficients, and so a given amount of production requires given levels of the various inputs. There is no substitution between inputs as output expands or contracts or as relative input prices change. If lower output leads to less employment and lower wages, firms cannot respond by employing more labour and less capital. These assumptions may be adequate for small changes, but they are less convincing for larger trade shocks.

2.3 Computable general equilibrium models

General equilibrium models (CGEs) take different forms, but the common features are coverage of the whole economy, with scarce endowments (land, labour, and capital) constraining production and income, which in turn constrain expenditure and consumption. CGE models usually involve large databases with linkages between sectors through SAM tables. Global models link countries through trade flows. As with partial equilibrium models, but absent from SAMs, CGEs contain behavioural equations. This implies consumers and producers respond to price changes, and it allows firms to employ more or less labour depending on relative prices. However, including behavioural equations raises the issue of what these parameters (elasticities) should be, and, since these relationships are the heart of the model, their value is sometimes contentious. CGE models usually have a macro component, with the trade balance and investment and savings taken into account.

An important structural identity is the requirement that the current account offsets the capital account, that is, savings minus investment equal exports minus imports:

$$S - I = X - M \quad (7)$$

Because this is an identity, at least one of these variables must be determined endogenously, inside the model. This is referred to as the “macroeconomic closure”, the

choice of variables as exogenous or endogenous. Usually, saving is fixed to income, which implies that investment determines the trade balance. This is important because policy-makers are keen to know whether trade liberalization will lead to, or worsen, a trade deficit. The trade deficit, $X-M$, can be fixed in the model, and this is a reasonable assumption if countries maintain a flexible exchange rate. In that case saving and investment must move in proportion.

Many models are neo-classical in nature, implying perfect competition, cost minimization by firms, and utility maximization by consumers. In practice, this means that prices clear markets. Of particular relevance to this paper, this implies that there is no unemployment or, at least, no change in employment. However, a simple change in closure can specify a labour market with fixed wages and variable employment. This is most relevant where surplus labour exists, as is the case in many developing countries.⁵

There are other approaches to modelling the labour market. On the supply side, micro-simulation based on individual household data may be useful. On the demand side, substitution possibilities between different types of labour have been considered. As for labour market coordination, several wage-forming mechanisms and involuntary unemployment models have been integrated into CGE models, including efficiency wages, bargaining, and minimum wage models.⁶ The specification of the labour market depends on the research question to be addressed. For example, if the distribution effects of trade liberalization are to be analysed, micro data at the household level are desirable. Micro-simulation provides greater detail but at the cost of greater data collection and complexity. Micro-simulation is more commonly applied to single-country CGE models than to global models.

Thus, CGE models combine the behavioural responses of partial equilibrium models with the intersectoral coverage of SAMs. As such, they are often the preferred approach for trade policy analysis.

2.3.1 The demand for labour

The demand for labour, as for any other factor of production, depends on the demand for the goods and services that labour can produce. Neglected in the discussion so far is the substitutability between labour and capital (figure 1) or, more specifically, between different types of labour. The substitution between labour and other factors of production can be defined in an aggregate production function linking output (Y) to the amount of capital (K) and labour (L) employed, thus:

$$Y = AK^\alpha L^{1-\alpha}; 0 < \alpha < 1 \quad (8)$$

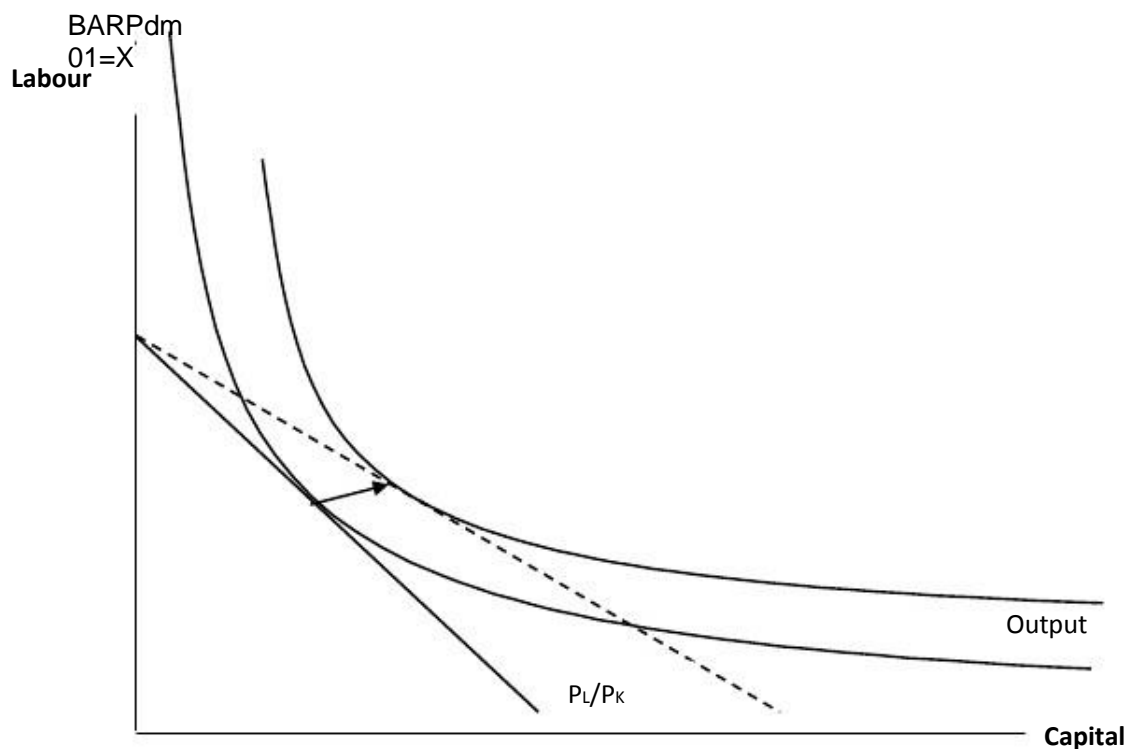
⁵ Kurzweil (2002) shows that in general models with variable employment lead to higher welfare gains from trade liberalization than those with fixed employment and variable wages, mainly because of a more efficient resource allocation and diminished unemployment.

⁶ Boeters and Savard (2012) provide an overview of labour market modelling approaches in CGE models.

where A is an overall productivity parameter and α and $1-\alpha$ are the elasticities of output with respect to capital and labour, respectively. In this specification the relationship between labour and output is non-linear, with increasing amounts of labour needed to produce a given increase in output, assuming capital is fixed. The curvature, or degree of non-linearity, is given by the parameter α .

Equation 8 can be extended to three or more factors of production. In the GTAP model labour is divided into skilled and unskilled. Land and natural resources are additional factors.

Figure 1: Trade-off between labour and capital



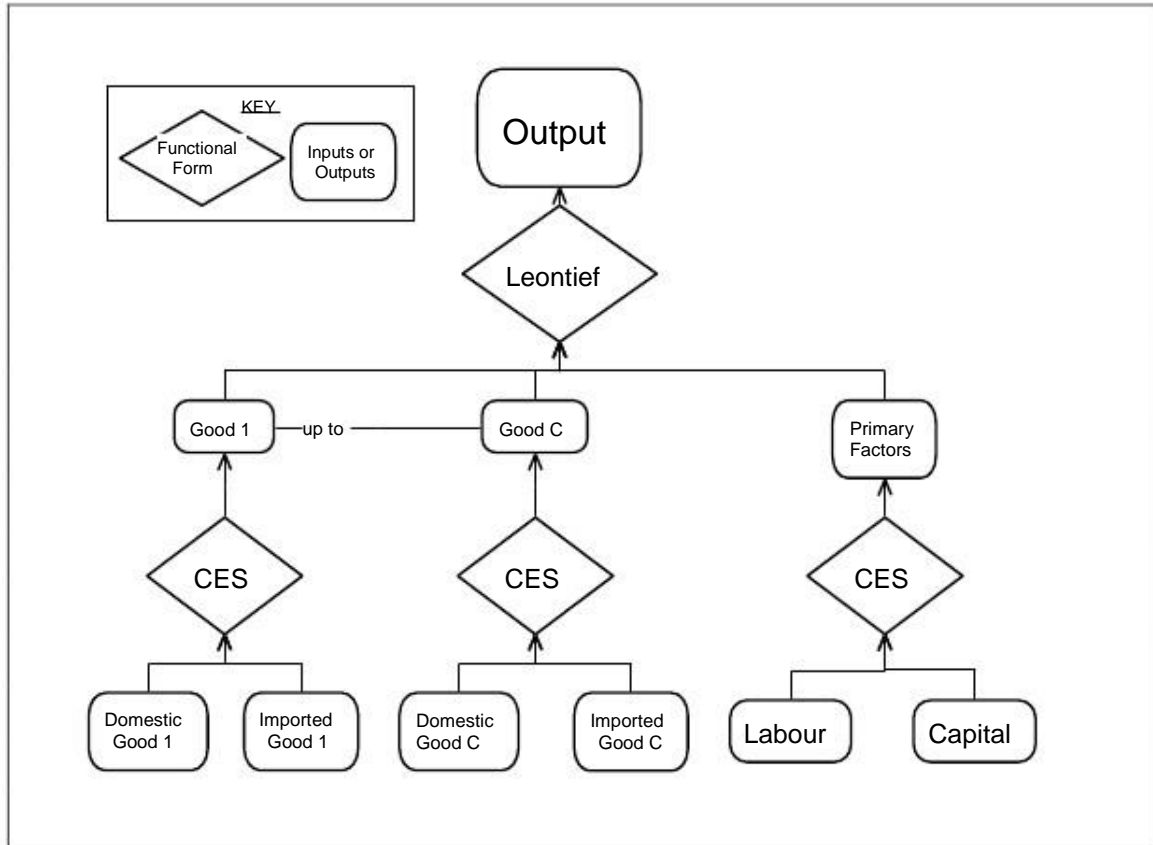
P_L/P_K is the price of labour relative to the price of capital.

The ratio shows the value of labour in total output at market prices (excluding taxes and subsidies). For most primary products labour contributes about 30-40 per cent of the costs. Bear in mind that wages are low in agriculture, so the ratios tend to understate the number employed.

As illustrated in figure 2, in GTAP output is a function of a bundle of primary factors (land, capital, and labour) plus a bundle of domestic and imported intermediate inputs, such as fuel and fertilizer. The primary factor composite and the intermediate good

composite each have a constant elasticity of substitution (CES) functional form. All industries have the same structure, but the proportions of inputs vary. Only agriculture uses land, for example. The bundle of primary factors and the bundle of intermediate inputs are combined using a constant elasticity of substitution functional form. Decision-making is in stages. The first stage is to decide how much to produce; this determines the amount of primary factors and intermediate inputs. The second stage is to determine the proportion of land, labour, and capital and the source (domestic or imported) of the intermediate goods.

Figure 2: Structure of production function in GTAP



CES = constant elasticity of substitution

In GTAP the demand in region r for use of endowment i in industry j is given by:

$$qfe(i,j,r) = qva(j,r) - ESUBVA(j) * [pfe(i,j,r) - pva(j,r)] \quad (9)$$

where **qfe** is the change in demand for the endowment, **qva** is the change in the value added composite, **pfe** is the change in the price of the endowment, **pva** is the change in the price of the value-added composite, and **ESUBVA** is the elasticity of substitution. This last parameter comes into play when there is a change in the prices of capital and labour. In these circumstances it is reasonable to expect a change in the capital–labour

ratios. Estimates for the elasticity of substitution between factors vary by type of agricultural commodity, as shown in table 1. These estimates are common across all regions. The low elasticity for primary agriculture suggests that capital and labour ratios are not sensitive to price, and, thus, changes in output (qva in equation 9) are a good guide to changes in use of all factors (qfe in equation 9). This conclusion does not hold for processed agriculture, where there is greater flexibility.

Table 1: Elasticities of primary factor substitution in the GTAP model

Product	Elasticity
Primary agriculture	0.26
Processed agriculture	1.12

Source: GTAP version 8 database.

Primary factors are combined with intermediate inputs to produce output. Intermediate inputs are normally assumed to be used in fixed proportions, but alternatively can be determined by relative prices, as shown in equation 10.

$$qf(i,j,r) = qo(j,r) - ESUBT(j) * [pf(i,j,r) - ps(j,r)] \quad (10)$$

where qf is the change in demand for commodity i for use by j in region r , qo is the change in industry output, $ESUBT$ is elasticity of substitution among composite intermediate inputs to production, pf is the change in firms' price for the commodity, and ps is the change in the supply price of the commodity. Parameter $ESUBT$ is normally zero, but in one of the scenarios we change its value to 1 for all agricultural sectors.

While the elasticities of substitution determine how capital, labour, and intermediate inputs respond to a change in relative prices, the initial flows data show the current levels of use of each input to production. Assuming there is no change in the prices of capital and labour, a change in output will lead to a change in employment in proportion to the labour–output ratio. The ratio shows the value of labour relative to total output at market prices (excluding taxes and subsidies). For most primary products labour contributes about 30–40 per cent of the costs. In agriculture wages are low, and so the ratios tend to understate the number employed. Table 2 shows labour–output ratios in different agricultural sectors in five countries. For example, around one-third of the cost of paddy rice production in Indonesia is attributable to labour. Processed goods tend to use relatively less labour and more capital and intermediate goods. Bangladesh appears to have lower labour–output ratios than Indonesia, a more developed country. This reflects the low cost of labour in Bangladesh.

Table 2: Labour–output ratios in agriculture in five countries

Product	Code	Indonesia	Bangladesh	Guatemala	Mexico	South Africa
Primary agriculture						
Paddy rice	pdr	0.35	0.22	0.33	0.39	0.17
Wheat	wht	0.06	0.12	0.19	0.18	0.10
Cereal grains nec	gro	0.36	0.26	0.29	0.36	0.14
Vegetables, fruit, nuts	v_f	0.38	0.23	0.26	0.34	0.16
Oil seeds	osd	0.33	0.14	0.34	0.09	0.15
Sugar cane, sugar beet	c_b	0.32	0.19	0.39	0.35	0.12
Plant-based fibres	pfb	0.38	0.19	0.29	0.13	0.08
Crops nec	ocr	0.33	0.20	0.38	0.30	0.20
Cattle, sheep, goats, horses	ctl	0.30	0.11	0.27	0.17	0.13
Animal products nec						
Raw milk						
Wool, silk-worm cocoons	oap	0.21	0.18	0.22	0.27	0.09
Forestry	rmk	0.25	0.11	0.29	0.10	0.12
Fishing	wol	0.19	0.00	0.23	0.15	0.07
	frs	0.29	0.02	0.14	0.47	0.05
	fsh	0.21	0.04	0.08	0.03	0.10
Processed agriculture						
Meat: cattle, sheep, cmt goats, horse		0.07	0.15	0.06	0.07	0.04
Poultry and other meats omt		0.37	0.16	0.10	0.23	0.04
Vegetable oils and fats vol		0.24	0.03	0.18	0.16	0.06
Dairy products mil		0.14	0.15	0.17	0.03	0.10
Processed rice pcr		0.07	0.02	0.35	0.69	0.01
Sugars gr		0.12	0.23	0.18	0.31	0.04
Food products nec o fd		0.16	0.07	0.14	0.23	0.12

nec = not elsewhere categorized

Source: GTAP version 8 database.

Other factors of production include land and capital. The capital–labour ratios for agriculture in these five countries are shown in table 3. These data, from the GTAP database, were derived from the National Accounts. The first row, for example, shows that capital accounts for 6 per cent of the value of output of paddy rice in Indonesia, 10 per cent in Bangladesh, and so on. This table can be used to predict employment in agriculture, given the simplifying assumption that capital, land, and labour are used in fixed proportions to produce any level of output. The processing industries tend to use more capital. They also use more intermediate inputs, in which capital and labour also are embodied. For example, beef uses 7 per cent labour, 7 per cent capital, and 75 per cent cattle. The production of cattle in turn uses 30 per cent labour (as shown in table 2). This is not taken into account in the data in table 3, but it is in general equilibrium simulations, to which we turn next.

Table 3: Capital–output ratios in agriculture in five countries

Product	Code	Indonesia	Bangladesh	Guatemala	Mexico	South Africa
Primary agriculture						
Paddy rice	pdr	0.06	0.10	0.17	0.24	0.26
Wheat	wht	0.01	0.06	0.10	0.12	0.15
Cereal grains nec	gro	0.06	0.12	0.15	0.23	0.22
Vegetables, fruit, nuts	v_f	0.06	0.11	0.14	0.21	0.26
Oil seeds	osd	0.06	0.07	0.18	0.07	0.24
Sugar cane, sugar beet	c_b	0.05	0.09	0.21	0.22	0.19
Plant-based fibres	pfb	0.06	0.09	0.15	0.09	0.13
Crops nec	ocr	0.06	0.09	0.20	0.19	0.31
Cattle, sheep, goats, horses	ctl	0.05	0.05	0.15	0.13	0.21
Animal products nec	oap	0.04	0.08	0.12	0.18	0.14
Raw milk	rmk	0.04	0.05	0.15	0.08	0.18
Wool, silk-worm cocoons	wol	0.03	0.00	0.13	0.09	0.10
Forestry	frs	0.44	0.34	0.05	0.08	0.28
Fishing	fsh	0.31	0.18	0.23	0.46	0.16
Processed agriculture						
Meat: cattle, sheep, goats, cmt horse		0.07	0.08	0.07	0.01	0.02
Poultry and other meatsomt		0.24	0.09	0.12	0.34	0.02
Vegetable oils and fatsvol		0.17	0.12	0.22	0.40	0.08
Dairy productsmil		0.09	0.08	0.20	0.06	0.06
Processed ricepcr		0.08	0.14	0.12	0.17	0.02
Sugarsgr		0.13	0.00	0.29	0.35	0.13
Food products necofd		0.18	0.21	0.27	0.04	0.10
nec = not elsewhere categorized						

Source: GTAP version 8 database.

A standard assumption in GTAP is that labour is mobile between sectors within a country and within a skill group. This includes, for example, the possibility that unskilled labour that became unemployed in an agricultural sector can be employed in the services or industrial sectors. This assumption can be changed to analyse the impact of less adjustable labour market structures on the effect of trade liberalization on employment.

2.3.2 Trade liberalization and labour demand

The effect of trade liberalization on employment and wages in agriculture depends on changes in the demand for such labour-intensive goods. Because protection of one specific product in a country increases output and employment of that product in that country, removing the protection will lead to a decrease. At the same time, however, falling prices following the removal of tariffs will lead to an increase in consumption. The increase in consumption, coupled with the fall in domestic production, creates a gap that is filled by increased imports. Therefore, employment typically falls in sectors where tariffs are reduced, as production shifts from one country to another. To maintain a balance of trade, exports need to increase to match any increase in imports

following trade liberalization. This means employment is likely to increase in exports industries. The net effect depends on the labour intensity of the import and export industries.

Labour intensity in production varies from country to country and product to product. If tariffs on a more labour-intensive product are removed while tariffs remain on less labour-intensive products, total employment in the agricultural sector will fall. This is a composition effect, whereupon the demand for labour falls because of a change in the composition of production.

Trade liberalization may also have indirect effects on employment in agriculture, e.g. prices for intermediate goods can change, and this can affect the relative use of primary and intermediate factors.⁷ Furthermore, trade may have an impact on growth, which has a further impact on demand for food products. A relatively sophisticated model is needed to capture the indirect effects.

1.3.3 Limitations of CGE modelling

In applying CGE models to questions on trade in agriculture and employment, several limitations ought to be kept in mind. Limitations that apply generally to CGE trade analysis include data and parameter limitations as well as simplifications and assumptions relating to the structure of the model. For example, no specific data are available on non-tariff measures. As tariffs are reduced, these other impediments are likely to play a greater role. Parameters are often not estimated for the particular model or level of aggregation. Armington elasticities, measuring the degree of substitutability between domestic and various foreign products, are not specific at the country or product aggregation level. Regarding the model, it is generally assumed that there is one representative firm per sector per country. However, the new trade theory and corresponding empirical evidence suggest that the size and the *ex ante* productivity of enterprises matter when trade is liberalized. Furthermore, most CGE applications are static, with no account taken of dynamic gains relating to technology, competition, and productivity growth. Nor is account taken of the one-off costs of structural adjustment, such as temporary unemployment. Dynamic models exist, but many assumptions regarding the growth path have to be made with a high degree of uncertainty.

Another limitation is that, when there is no initial trade – for example, due to prohibitively high tariffs – trade liberalization does not generate any flows in CGE models. Careful aggregation of regions and sectors can minimize this problem. However, aggregation creates problems of its own by hiding the distortions between differing tariffs within a sector. Laborde et al. (2011) develop an approach that addresses the deficiencies stemming from aggregating and uses trade-weighted average distortions. Although their approach does not solve the problem with zero initial trade, it makes use of the availability of trade data, which are more detailed than consumption and

⁷ Since intermediate goods are again produced using labour, this effect is similar to the productivity effect.

production data, by using different aggregators. The result is that welfare gains are significantly higher than those measured in analysis using aggregated data.

A limitation that relates more specifically to trade liberalization and employment in agriculture is the diversity of production processes and the informality of the labour force. Industrial-type capital-intensive production and labour-intensive smallholder production, often at a subsistence level, co-exist, often in the same sector in the same country. The effect of trade liberalization is likely to differ greatly between the two types of production. This is difficult to capture in CGE models. An approach to overcome this limitation is to link a global CGE model with country-specific micro data. Hertel and Winters (2005) take this approach, attempting to assess the impact of trade liberalization negotiations on poverty in the developing world by following the effect of global shocks, through their effects on prices, trade, production, and earnings, right down to the household level. Vanzetti and Oktaviani (2012, chapter 7 in this volume) link a disaggregated country-specific CGE model with the global GTAP model. Sinha (2011) discusses the effects of trade on the informal economy and the opportunities for and limitations of such analysis in CGE models. The objective of this strand of analysis has been to assess distribution effects between the formal economy and the informal economy rather than to refine the assessment of the effect of trade liberalization on employment in a sector as a whole.

In GTAP all data including employment are in value terms. Thus, information about the initial number or the change in the number of workers in agriculture is not directly available. If trade liberalization results in a contraction of labour demand in a high-wage country by US\$1,000, for example, and an expansion of the same amount in a low-wage country, global employment increases. Agricultural value added per worker, an indicator for wages, varies from a few hundred US\$ in, for example, many African countries to values around US\$50,000 in countries such as Canada, the United States of America, and many European countries (WDI, 2012).

An issue stemming from the agricultural negotiation process is that often the countries themselves can select at a later stage, based on certain criteria, which products are deemed sensitive and thus exempt from (full) liberalization. The special treatment given to sensitive products weakens the level of ambition and the potential gains, but it can have positive effects for domestic producers. Since the actual selection is not known *ex ante*, different approaches to identifying the sensitive products have been taken. For example, Anderson et al. (2006a) select products according to the tariff revenue forgone through implementation of the tariff reduction formula proposed in the draft modalities text (WTO, 2008); Vanzetti and Peters (2011), according to the percentage difference between bound and applied rates in developing countries; and Laborde and Martin (2011), according to a political economy approach. Furthermore, the binding overhang is particularly large in agriculture, and so reduction commitments in multilateral negotiations on bound rates do not reflect actual cuts in applied rates.

3 Illustrative scenarios

3.1 *Illustrative scenario; unilateral liberalization*

To illustrate the impact of different features of a general equilibrium model, we run a trade liberalization scenario with different parameters and labour market closures. The Standard scenario is unilateral liberalization of all agriculture import tariffs in Indonesia, Bangladesh, and Guatemala using the version 8 database of GTAP. The variations of this scenario involve the different assumptions listed in table 4.

Table 4: Labour market assumptions

Scenario	Description
Standard	Standard closure, with fixed total employment and variable wages
Rigid	Fixed real wages for unskilled labour
Primary	Standard closure, with doubling of elasticity of substitution between primary factors. This is parameter ESUBVA in equation 9.
Intermediates	Standard closure, with substitution between intermediate inputs. This is parameter ESUBT in equation 10.

The first scenario, Standard, is the standard neo-classical closure in which it is assumed that all factors of production are employed but are mobile between sectors. Scenario 2, Rigid, is the Keynesian closure, where surplus unskilled labour exists and wages are fixed. Scenario 3, Primary, shows the effects of increased mobility between factors of production, including between unskilled and skilled labour, and Scenario 4, Intermediates, illustrates the effects of greater substitution between primary factors and intermediates. The elasticity is normally zero, but here it is changed to 1. This relaxes the assumption that intermediates need to be used in fixed proportion to capital and labour.

Results

The simulated changes in real wages under the different assumptions are shown in table 5. In each case the changes in real wage are positive, except where real wages of unskilled labour are held fixed. Real wages increase because imports become cheaper. A second observation is that the changes in skilled and unskilled wages are about the same. Unilateral liberalization in agriculture does not lead to an increase in demand for skilled as opposed to unskilled labour. Land rents decrease, however, in the liberalizing countries by about 1.5 per cent. In so far as total income from agricultural activities for (small) farmers is a mixture of wage and land rent, some may be worse off.

Employment in the agricultural sector is decreasing in all scenarios. This occurs particularly because liberalization occurs in agriculture only. Liberalization in all sectors might result in an increase in agricultural employment if there are larger cuts in industrial sectors. With agricultural liberalization only, agricultural imports increase

when markets are opened, and imports replace some domestic production. In Bangladesh employment in the agriculture sector decreases by almost 2 per cent in the Standard scenario. Employment increases in non-agriculture sectors, however. In the Rigid scenario, with fixed wages, the increase in non-agriculture employment more than offsets losses of employment in the agriculture sector. In the Rigid scenario the total quantity of unskilled labour employed increases by 0.45 per cent in Indonesia, 1.37 per cent in Bangladesh, and 0.78 per cent in Guatemala (table 5), similar to the increases in real wages for skilled labour (table 6). As expected, fixing real wages boosts employment, as the increase in demand for this type of labour is channelled into a quantity change rather than a price change. The assumption of fixed wages also holds down the cost of production, making the country more competitive.

In the Primary scenario policies that increase the substitutability between primary factors, such as skilled and unskilled labour, or capital and land, have little impact on wage changes. If anything, the real wage change rates are slightly reduced, for example in the Indonesian case from 0.30 to 0.24 per cent (table 6).

Table 5: Simulated percentage changes in unskilled employment

	Indonesia		Bangladesh		Guatemala	
	AgriN-ag	Total	AgriN-ag	Total	AgriN-ag	Total
Standard	-0.51 0.14	0	-1.96 0.31	0	-0.57 0.17	0
Rigid	-0.25 0.65	0.45	-1.20 1.77	1.37	-0.28 0.95	0.78
Primary	-0.44 0.12	0	-2.12 0.34	0	-0.49 0.15	0
Intermediates	-0.35 0.10	0	-2.06 0.33	0	-0.36 0.11	0

Agri = agriculture; N-ag = non-agriculture
Source: GTAP simulations.

Table 6: Simulated percentage changes in real wages

	Indonesia		Bangladesh		Guatemala	
	Unskilled	Skilled	Unskilled	Skilled	Unskilled	Skilled
Standard	0.30	0.30	0.83	0.85	0.42	0.46
Rigid	0	0.41	0.15		0	0.64
Primary	0.24	0.26	0.79	0.72	0.39	0.39
Intermediates	0.25	0.29	0.81	0.83	0.41	0.44

Source: GTAP simulations.

Table 7 shows changes in output and employment of unskilled labour in a sensitive agricultural sector in each country. Indonesia has a tariff of 22 per cent on sugar imports from its major supplier; Bangladesh has a tariff of 17 per cent on sugar imports from South Asia; and Guatemala has a tariff of 22 per cent on imports of maize (Cereal grains nec) from the USA.

While holding wages fixed reduces production costs in the case of increasing demand, the absence of wage flexibility lessens adjustment in the economy. For this reason the simulated changes in output are less in the Rigid scenario than in the Standard scenario, where the total quantity of unskilled labour is fixed.

The change in employment is closely associated with the change in output in the sector. Fixing real wages has little impact on the change in employment in a specific sector in Indonesia; the impact is more noticeable in Bangladesh. Increasing the mobility of primary factors lessens the reduction in output, as a change in the mix of capital and labour can make the sector more competitive. The reduction in output is less in the Primary scenario than in the Standard scenario. By contrast, increasing the mobility of intermediates increases the reduction in output because primary factors can move more readily into other sectors.

Table 7: Simulated percentage changes in output and employment of unskilled labour in sensitive sectors

	Indonesia		Bangladesh		Guatemala	
	Output	Employment	Output	Employment	Output	Employment
Standard	-14.19	-16.63	-6.97-8.28		-4.14-4.49	
Rigid	-13.82	-15.74	-5.15-4.87		-3.73-3.72	
Primary	-14.92	-18.60	-7.16-8.84		-4.20-4.75	
Intermediates	-13.46	-14.91	-5.95-8.56		-3.24-3.47	

Note: "Sugar" in Indonesia and Bangladesh and "Cereal grains nec" in Guatemala.

Source: GTAP simulations.

There is a trade-off between efficiency and adjustment costs. Greater flexibility leads to more efficient outcome but also requires greater adjustment in the short run. As table 8 shows, the Primary scenario, where primary factors are assumed to be more substitutable, shows greater allocative efficiency gains than the Standard scenario. However, improving the mobility of intermediate inputs appears to have little or no impact on efficiency. The two other important components of welfare are terms-of-trade effects and endowment (employment) effects. The terms-of-trade effect is negative in unilateral liberalization. In the Standard scenario it is greater than the allocative efficiency effect, so that the total welfare effect is negative in all three countries. In the Rigid scenario the endowment effect, resulting from higher total employment of unskilled workers, is positive and large in each of the three countries, so that the total welfare effect is positive.

Table 8: Simulated changes (in \$m) in allocative efficiency

	Indonesia	Bangladesh	Guatemala
Standard	81	26	12
Rigid	134	102	17
Primary	100	50	15
Intermediates	90	45	12

Source: GTAP simulations.

The employment effects vary more than the change in output when substitution between factors of production is assumed. Table 9 shows the percentage change in use of unskilled labour in each of the agricultural sectors in Guatemala for two scenarios. There are decreases of more than one per cent in rice, other cereals, and meat. Other agricultural sectors expand significantly. More importantly, however, the assumption of either variable or fixed wages makes a sizeable difference to the change in total and non-agricultural employment, although not much for the agricultural sectors. This highlights not only the assumption of a surplus of unskilled labour, but also the need for a labour market that enables the unemployed to find work.

Table 9: Simulated percentage changes in employment of unskilled workers in Guatemala by sector

Product	Standard	Rigid
All agriculture	-0.57	-0.28
Paddy rice and processed rice	-1.06	-1.34
Wheat	1.92	1.70
Other cereals	-4.20	-4.38
Oilseeds	0.50	0.22
Vegetable oils and fats	10.06	9.57
Sugar	0.77	0.32
Vegetables and fruit	-0.38	-0.57
Other crops	1.60	1.37
Livestock	-0.12	-0.37
Ruminant meat	-0.70	-1.20
Non-ruminant meat	-16.71	-17.18
Other processed agriculture	0.48	-0.10
Non-agriculture	0.17	0.95

Source: GTAP.

3.2 Illustrative scenario: multilateral liberalization

Unilateral trade liberalization in agriculture only leads to a decrease in employment in that sector. When lowering barriers to agricultural trade, negotiators want to ensure that “gains” from higher levels of exports of other goods and services, due to better access to other countries’ markets, compensate for the “pain” of higher levels of

imports. The WTO's Doha Round of multilateral trade negotiations in agriculture aims at substantial improvements in market access, reductions, with a view to phasing out, of all forms of export subsidies, and substantial reductions in trade-distorting domestic support. Special and differential treatment provisions are integral parts of all elements of the negotiations.⁸ After a decade of negotiations, the Doha Round is in stalemate, and its future is uncertain. Agriculture was for most of the time at the centre of attention and controversy (UNCTAD, 2011). Agriculture is a politically sensitive sector in almost all countries and important for food security as well as employment, especially in developing countries. This section illustrates the possibilities and limitations of CGE models to assess the impact of multilateral liberalization on employment. In contrast to unilateral liberalization, multilateral liberalization provides access for increased exports, thus making the increase in imports easier to tolerate.

The draft modalities text for agriculture in the Doha Round negotiations includes detailed provisions on market access, domestic support, and export competition. The exceptions and special provisions for individual countries and country groups are many; analysing these specific provisions would shed more light on the effects of such special provisions than on the general effect of multilateral trade negotiations. Several studies have analysed specific provisions, e.g. Vanzetti and Peters (2011) and Jean et al. (2006). Here, the liberalization scenario assessed is based on the overall average cuts that would result from the Doha Round as proposed in the current draft modalities texts for agriculture. Laborde and Martin (2011) show the impact of the draft modalities text for agriculture (WTO, 2008) on applied tariffs. Thus, the overall level of ambition is in line with the draft modalities text, reflecting the most likely politically feasible outcome of multilateral trade negotiations in agriculture.

Proposed tariff cuts are higher in developed countries than in developing countries. This results from the special and differential treatment principle as well as from the fact that negotiations are on bound rates, where developing countries have a higher binding overhang. Applied rates are reduced by 33 per cent in developed countries and 10 per cent in developing countries. Trade-distorting domestic support is reduced by 55 per cent in developed countries, and export subsidies are eliminated.⁹ The least developed countries (LDCs) are exempt from reduction commitments.

As with the unilateral liberalization scenarios, we assess the implication of different labour market assumptions. Three scenarios are simulated: the Standard scenario, where the number of workers is fixed and wages adjust to clear the labour market; a Variable scenario, where both wages and employment adjust in approximately equal

⁸ For detailed information on the Doha Round negotiations on agriculture, see chapter 2 and references therein. Also, Martin and Mattoo (2011) provide a comprehensive overview of the Doha Round.

⁹ Blandford and Josling (2011) analyze the potential effect of the proposal on domestic support reduction of the draft modalities text for agriculture (WTO, 2008) on applied rates of domestic support in the EU and the United States.

shares to changes in demand; and the Rigid scenario, where wages are fixed and all adjustment is through higher or lower employment (table 10).

Table 10: Multilateral liberalization scenarios

Scenario	Tariff reduction	Trade-distorting domestic support	Labour market
Standard	Developed: -33% Developing: -10% LDC: no change	Developed: -55% Developing: no change	Fixed quantity of unskilled labour
Variable	Developed: -33% Developing: -10% LDC: no change	Developed: -55% Developing: no change	Adjustment in both wages and employment
Rigid	Developed: -33% Developing: -10% LDC: no change	Developed: -55% Developing: no change	Fixed wages of unskilled labour

Studies using general equilibrium models to assess the effect of trade liberalization on employment usually find relatively small effects (table 11). This is partly the consequence of the labour market assumption, where unemployment is often not explicitly modelled. Where employment is not fixed, developing countries appear to benefit in terms of employment in agriculture, while initially protected developed countries tend to lose employment in that sector.

Table 11: Overview of selected studies assessing the effect of trade liberalization

	Labour market	Scenario	Employment
Anderson et al. (2006a) Linkage model	Recursive dynamic model with exogenous labour supply growth; labour markets clear with flexible prices	“Scenario 7”, agriculture and non-agriculture market access (NAMA) liberalization; tiered formula with tariff cuts between 35 and 75 per cent in agriculture, no cuts in LDCs “Standard scenario”,	Employment rate decreases by –0.7% in developed countries and increases by 0.1% in developing countries compared with baseline (world –1.0%); full liberalization: developed, –1.6%; developing, +0.2% (world: –2.1%)
Decreux and Fontagné (2006) MIRAGE model	Production factors fully employed; negative shocks absorbed by changes in prices	agriculture liberalization only; 36% reduction of tariffs	Employment losses in EU, Japan, USA of about 2–3 per cent; gains in sub-Saharan Africa and South America of about 2–3 per cent. Countries affected by erosion of preferences and changes in relative prices lose in terms of welfare. Employment in developing
Polaski (2006) Carnegie model	Separated rural labour and urban skilled and unskilled labour; rural employment has flexible wages; migration between rural and unskilled urban (where wages are fixed)	“Hong Kong” scenario, reduction of all distortions by 36 per cent in developed countries and 24 per cent in developing countries; LDCs exempt	countries +0.76% (agriculture +1.46%); in developed countries, +0.08% (agriculture –1.74%)

10

Results

Global agricultural trade increases by 2 per cent in the Standard and Variable scenarios and by 2.2 per cent in the scenario with fixed wages (table 12). Behind the average changes are some significant country- and product-specific changes. For example, exports of meats from the USA to Japan increase by 26 per cent for ruminant meat and 36 per cent for non-ruminant meat. All countries increase their exports, except Bangladesh, the European Union (EU), Mexico, and the rest of the world. Japan’s exports are very low for all product groups, and so the positive change in total exports from Japan starts from a very low base; it is driven by higher exports of other processed agriculture products. Exports increase most for competitive agricultural producers. The most competitive country groups are other developed countries, which include Australia, Canada, and New Zealand, all Cairns group members; and Latin America, with e.g. Argentina and Brazil. Exports from China, North Africa and the Middle East, and the United States also increase disproportionately, while exports from Bangladesh, the EU, and Mexico decline. The decline in the EU is caused mainly by reduced subsidies.

¹⁰ Agriculture employment changes calculated as simple average from corresponding sectors.

Bangladesh and Mexico as well as African LDCs, where export growth is disproportionately low, are negatively affected by preference erosion.

Table 12: Estimated percentage changes in agricultural exports and imports under multilateral trade liberalization scenarios

	Standard		Variable		Rigid	
	Exports	Imports	Exports	Imports	Exports	Imports
European Union	-1.70.6		-1.70.6		-0.80.6	
United States	4.22.1		4.22.1		3.72.2	
Japan	6.06.9		6.06.9		5.57.0	
Other developed	8.97.5		9.07.6		8.87.6	
China	6.71.6		6.71.6		6.21.6	
Indonesia	2.91.4		2.91.4		2.71.4	
Bangladesh	-1.4-0.1		-1.4-0.1		-1.6-0.1	
Guatemala	0.70.7		0.70.7		-0.30.7	
Mexico	-1.10.2		-1.10.2		-1.30.2	
South Africa	3.21.2		3.21.2		2.31.3	
South-East Asia	3.11.9		3.11.9		2.81.9	
South Asia	2.74.8		2.74.9		2.24.9	
Eastern Europe and West Asia						
Central America						
Latin America						
North Africa and Middle East	2.9	1.5	2.9	1.5	2.1	1.5
Sub-Saharan Africa, non-LDC	3.1	1.8	3.1	1.9	2.9	1.9
Sub-Saharan Africa, LDC	5.3	2.4	5.3	2.5	4.7	2.5
Rest of world						
World	7.2	2.0	7.2	2.0	6.8	2.0
Source: GTAP simulation.	2.2	1.6	2.2	1.6	2.1	1.6
	0.3	-0.1	0.3	-0.1	0.1	-0.1
	-0.6	0.0	-0.6	0.0	-1.0	0.0
	2.0	2.0	2.0	2.1	2.2	2.1

Imports increase in all regions except Bangladesh and sub-Saharan LDCs. Being exempt from trade liberalization, these countries do not reduce tariffs. Slightly rising world food prices lead to lower imports. The increase in imports to other countries is mainly modest, at around 1 per cent to 3 per cent. Imports of Japan and other developed countries increase by about 7 per cent. Broadly, the changes in imports and exports are similar in each country. The reason is that there is no alternative use for land and limited alternative use for labour in other sectors. Therefore, CGE models predict that trade liberalization leads to shifts in the composition of agricultural trade and production rather than a complete move into industrial goods and services production. Indeed, the average changes in exports and imports hide greater changes in the composition of

trade and production despite the moderate change in tariffs. Imports of rice to Japan, for example, increase by 120 per cent.

In these scenarios very few countries experience large aggregated reductions in output (table 13). Most significant are the reductions in the relatively highly protected EU and Japan. Changes in particular sectors, however, can be very high, up to 50 per cent. There is a shift of production from developed countries to developing countries – or, rather, from less competitive agricultural producers to more competitive producers. Competitive developed-country agricultural producers such as Australia and New Zealand, for example, benefit, while some developing countries are worse off. In developed countries total output is expected to decrease by 0.5 per cent, while in developing countries total production would increase by 0.3 per cent. Global output is expected to decrease slightly due to a reduction of production subsidies.

Table 13: Impact on output in agriculture under the multilateral trade liberalization scenarios

	Standard (% change)	Variable (% change)	Rigid (% change)
European Union	-0.92	-0.91	-0.91
United States	0.32	0.33	0.33
Japan	-2.21	-2.20	-2.19
Other developed	0.77	0.86	0.94
China	0.16	0.17	0.17
Indonesia	0.30	0.30	0.30
Bangladesh	-0.03	-0.03	-0.03
Guatemala	0.30	0.31	0.32
Mexico	-0.15	-0.15	-0.15
South Africa	0.35	0.36	0.37
South-East Asia	0.56	0.57	0.58
South Asia	-0.18	-0.16	-0.14
Eastern Europe and West Asia	0.11	0.11	0.12
Central America			
Latin America			
North Africa and Middle East	0.12	0.14	0.15
Sub-Saharan Africa, non-LDC	1.28	1.28	1.29
Sub-Saharan Africa, LDC	0.44	0.47	0.49
Rest of world	0.13	0.16	0.19
	0.13	0.12	0.12
	-0.13	-0.13	-0.13

Source: GTAP simulation.

Changes in output result in changes of a similar magnitude in unskilled employment in the agriculture sector (tables 3.13 and 3.14). The assessed impact on employment is

relatively small. Employment in agriculture decreases in one-third of the countries and increases in the other two-thirds. The greatest drop, of about 2.5 per cent, occurs in Japan, and the greatest increase, of about 1.25 per cent, is in Latin America. Variation in agricultural employment is very similar in the countries under each scenario, indicating that the impact of trade liberalization on employment in specific sectors is not very sensitive to the assumption concerning whether adjustment is through wages or total national employment. Employment in agriculture in developed countries decreases (by –0.56 per cent to –0.62 per cent), while in developing countries it increases (by 0.25 per cent to 0.28 per cent). Where total employment can adjust, it increases in almost all regions except Bangladesh, sub-Saharan African LDCs, and rest of the world. This reflects a fall in demand for labour-intensive goods produced in these countries. Where agricultural employment decreases, surplus labour finds jobs in the industry and services sectors.

Table 14: Impact on unskilled employment under the multilateral trade liberalization scenarios

	Standard		Variable		Rigid	
	Agriculture (% change)	Total (% change)	Agriculture (% change)	Total (% change)	Agriculture (% change)	Total (% change)
European Union	-1.030		-1.020	0.01	-1.020	0.02
United States	0.340		0.350	0.01	0.370	0.03
Japan	-2.520		-2.490	0.05	-2.450	0.10
Other developed	0.100		0.280	0.29	0.450	0.58
China	0.200		0.200	0.00	0.200	0.00
Indonesia	0.380		0.380	0.00	0.390	0.01
Bangladesh	-0.010		-0.020	-0.01	-0.020	-0.02
Guatemala	0.040		0.060	0.03	0.070	0.06
Mexico	-0.120		-0.120	0.00	-0.120	0.00
South Africa	0.380		0.400	0.02	0.410	0.04
South-East Asia	0.640		0.660	0.05	0.690	0.09
South Asia	-0.130		-0.090	0.08	-0.050	0.15
Eastern Europe and West Asia	0.120		0.130	0.02	0.140	0.04
Central America						
Latin America						
North Africa and Middle East	0.12	0	0.16	0.06	0.19	0.13
Sub-Saharan Africa, non-LDC	1.24	0	1.25	0.03	1.27	0.06
Sub-Saharan Africa, LDC	0.21	0	0.25	0.08	0.30	0.15
Rest of world						
Developed countries	0.07	0	0.11	0.06	0.15	0.12
Developing	0.09	0	0.08	0.00	0.08	-0.01
	-0.09	0	-0.09	-0.01	-0.10	-0.03
	-0.62	0	-0.59	0.05	-0.56	0.10
	0.25	0	0.27	0.02	0.28	0.05

countries						
World	-0.10	0	-0.08	0.05	-0.06	0.09

Source: GTAP simulation.

Globally, the estimated value of labour costs in agriculture decreases by a range of –0.06 to –0.1 per cent following implementation of the Doha Round (table 14). This does not mean that CGE results predict that multilateral trade liberalization along the level of ambition of the Doha Round leads to a decrease in global employment in agriculture. In developed countries the value of labour costs in agriculture decreases by US\$3 billion, and in developing countries it increases by US\$2 billion. Since labour costs are significantly higher in developed countries than in developing countries, this shift would imply an increase in total employment if developed-country wages are 50 per cent higher than developing-country wages. Since the difference in wages is, in fact, much greater,¹¹ the shift of production from the North to the South implies that, globally, agricultural employment increases. Since wages vary within the groups of developed and developing countries and even between sectors, adding up values to indicate changes in countries or country groups is problematic. More specific data in CGE models or linked labour satellites would be needed to yield more detailed information about the impact of trade liberalization on employment, for example, by occupation or location.

The impact of trade liberalization on total employment in a country depends on the structure of the labour market. If the supply of labour is fixed, as in the Standard scenario, all the adjustment occurs through changes in wages. An increase in demand leads to an increase in wages. In the Fix scenario changes in wages are very small and follow the direction of changes in employment (table 15).

Table 15: Estimated impact on real wages of unskilled labour under the multilateral trade liberalization scenarios

	Standard (% change)	Variable (% change)	Rigid (% change)
European Union	0.01	0.01	0
United States	0.01	0.01	0
Japan	0.05	0.02	0
Other developed	0.30	0.15	0
China	0.00	0.00	0
Indonesia	0.01	0.01	0
Bangladesh	–0.01	–0.00	0
Guatemala	0.04	0.02	0
Mexico	0.00	0.00	0
South Africa	0.02	0.01	0

¹¹ The average wage in agriculture in the USA, for example, is US\$1,909 and in Mexico, US\$198 per month (ILO Laborstat).

South-East Asia	0.06	0.03	0
South Asia	0.11	0.05	0
Eastern Europe and West Asia	0.03	0.01	0
Central America	0.07	0.04	0
Latin America	0.03	0.02	0
North Africa and Middle East	0.10	0.05	0
Sub-Saharan Africa, non-LDC	0.10	0.05	0
Sub-Saharan Africa, LDC	-0.01	-0.00	0
Rest of world	-0.01	-0.00	0

Source: GTAP simulation.

Effects on tariff revenues are small and can change in either direction. Lower tariffs suggest lower tariff revenue, but rising imports lead to a larger base and thus can lead to higher tariff revenues. Typically, tariff revenues from agriculture are lower than revenues from non-agricultural products, since trade in agriculture is only about 10 per cent of total merchandise trade.

The global welfare effects are positive in all three scenarios, as shown in table 16. If labour is in surplus, the increase in employment has a significant effect on national welfare. Countries not liberalizing may experience welfare losses, if they are significant importers of agricultural goods, since world prices of agricultural goods would increase slightly following liberalization. In addition, preference erosion can lead to negative effects.

Table 16: Impact on welfare under the multilateral trade liberalization scenarios, in US\$m

	Standard	Variable	Rigid
European Union	4 714	5 242	5 652
United States	839	1 690	2 359
Japan	2 258	3 046	3 808
Other developed	4 272	9 291	14 317
China	379	367	332
Indonesia	88	102	120
Bangladesh	-9	-12	-16
Guatemala	2	5	8
Mexico	-14	-4	10
South Africa	30	49	70
South-East Asia	372	497	624
South Asia	527	870	1220
Eastern Europe and West Asia	95	455	767

Central America	92	175	256
Latin America	1 238	1 539	1 823
North Africa and Middle East	-36	81	203
Sub-Saharan Africa, non-LDC	60	131	206
Sub-Saharan Africa, LDC	-7	7	25
Rest of world			
World	0	0	0
	14 900	23 530	31 784

Source: GTAP simulation.

Annual welfare impacts for each region are divided into allocative efficiency, endowment, and terms-of-trade effects. Allocative efficiency effects refer to how well resources are allocated within a country or region and reflect the variations in tariffs and other taxes within the economy. If these effects are negative, it means that the policy changes result in resources moving into the more protected sectors. With partial liberalization this is often the outcome in non-participating countries, but it also can occur in the liberalizing countries. In the Variable scenario the allocative efficiency increases on all regions except Bangladesh and LDCs in sub-Saharan Africa.

The second component of welfare is changes in the use of an endowment. This refers to the change in the use of unskilled labour, which is endogenous in the Variable and Rigid scenarios. The endowment effect is a major contributor to the positive welfare gains in these scenarios. The global welfare effect increases from US\$15 billion in the Standard scenario to US\$32 billion in the Rigid scenario, mainly due to the endowment effect (table 16).

The third component of welfare is terms of trade. This refers to the changes in the ratio of export to import prices. The terms of trade sum to zero globally, as a rise in the price of exports in one country corresponds to a rise in import prices in another. An improvement in one country's terms of trade often reflects improvements in market access. The terms-of-trade effects are negative and large in most developed regions. They are positive for LDCs in sub-Saharan Africa and in the Variable and Rigid scenarios compensate for the losses stemming from the other welfare components.

The highest benefits from multilateral trade liberalization in agriculture come from import tariff reductions (about 65 per cent of total welfare gains). The reduction and/or elimination of domestic support and export subsidies contribute to the benefits but account for only about 11 per cent and 3 per cent of the global gains, respectively. Anderson et al. (2006b) and Peters (2006) confirm that increasing agricultural market access has much more potential to generate welfare gains than reduction of trade-distorting domestic support and export subsidies. The fact that reduction commitments on trade-distorting domestic support are made from bound levels, which are mostly

well above current spending, contributes to this result. Export subsidies have been extensively used during the 1990s but since have dwindled to very low levels.

4 Conclusions

Trade liberalization in agriculture has an impact on employment in that sector through changes in output. The effect of trade on employment through indirect effects such as economic growth or income effects is likely to be positive but slight. The key factor is the ability to move labour from one sector to another. Keeping factors of production fully employed is important.

Several techniques can be used to quantify trade and employment effects. They include partial equilibrium models, social accounting matrix analysis, and CGE models. The former two are less demanding in terms of data and construction. Partial equilibrium models are flexible enough to focus on a particular sector and are best used when the linkages between sectors are not of interest. A social accounting matrix is transparent and easy to use and understand. CGE models, however, address several shortcomings such as linkages between the sectors or missing behavioural assumptions such as substitution between capital and labour when relative prices change.

CGE models are often the preferred choice to analyse the effects of trade liberalization. GTAP or similar models using the same database, such as Mirage (Centre d'Etudes Prospectives et Information Internationale) or Linkage (World Bank), have been used frequently to assess the effects on developing countries of liberalizing the agricultural sector. Few analytical studies analyse the employment effects directly and in great detail. Often, simple labour market assumptions are made, and the lack of data on employment per sector complicates potential analysis of the labour market implications. A crucial assumption is whether adjustment occurs in wages, which is the default assumption, or employment. Real wages and employment are found to be very sensitive neither to the substitutability between primary factors of production nor to the substitutability of intermediate inputs. However, the ability to utilize all resources fully, including labour, is important; welfare effects can vary significantly, with higher gains when labour surplus is assumed. The results highlight the advantage of a functioning labour market that can readily adjust to trade shocks and mobilize additional labour if demanded.

Unilateral liberalization in agriculture leads to less employment in that sector but can lead to an overall increase in employment in a country; real wages increase. Multilateral liberalization in agriculture shifts employment from the more protected North, especially the EU, Japan, and few other developed countries, to the South. Employment in agriculture in developing countries as a group is expected to increase as a result of liberalization of agricultural trade. Effects within the group of developing countries vary, with higher gains in employment in more competitive agricultural producers such as Latin America. Total employment, i.e. agriculture, industry, and services employment,

increases in most countries as a result of increases in global output. Whether the increased demand for labour is reflected in higher wages or in more employment depends on the functioning of the labour market. With full employment, wages must rise, raising the cost of production and choking off demand.

Since data on the volume of employment is not included in GTAP, it is difficult to assess the impact on the number of workers in agriculture. However, due to expanding values of labour in developing countries and lower labour costs per worker, the analysis indicates that global employment would increase as a result of agricultural trade liberalization. The positive effect predicted by CGE models such as GTAP is, however, quite small.

Global annual welfare gains are positive at between US\$15 billion and US\$32 billion, depending on the assumed structure of the labour market. Typically, a larger share of the welfare gain accrues in developed countries, as these countries experience greater tariff reductions and consequently their consumers benefit from lower prices. Their taxpayers may also benefit from the lowering of subsidies. Welfare gains in developing countries are positive, too, and these countries also benefit from higher employment, output, and exports. Losses in tariff revenue are usually negligible, since the revenue from agricultural trade is relatively low. Special attention needs to be paid to some specific countries – some of the poorest and most vulnerable – which may be adversely affected by rising import bills and preference erosion. If this attention is provided and corresponding complementary measures are taken, multilateral agricultural liberalization has a positive employment and development impact. A higher level of ambition than the one that has been assessed here, which broadly follows the Doha Round, would lead to greater gains and losses, with higher global welfare gains and greater specialization in the production of goods in which countries have a comparative advantage. The latter may be a concern in terms of food security and dependence on food imports. This has not been discussed here.

Several limitations of CGE modelling should be kept in mind. Good-quality data and precisely estimated parameters are important. Data aggregation to, for example, 57 sectors, as in GTAP, can be problematic, especially if certain products are excluded from liberalization. Furthermore, simplifying assumptions such as perfect competition are made. The dynamic effects in the modelling, including not only the gains from investment and technology transfer but also the cost of moving resources from one sector to another, are usually ignored. Dynamic models need to make strong assumptions about growth expectations. Therefore, the results are not objective facts, providing unambiguous numerical measures of the value or risks of liberalization, and they should not be reported as such (Ackerman and Gallagher, 2008). However, when these limitations are kept in mind and are reported, and results are interpreted carefully, CGE models are useful tools to better understand the complex potential effects of trade liberalization on employment.

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