GLOBAL TRADE MODELS AND ECONOMIC POLICY ANALYSES:

RELEVANCE, RISKS AND REPERCUSSIONS FOR AFRICA[1]

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Computable general equilibrium (CGE) models are widely used for trade policy analyses and recommendations. There is, however, increasing discomfort with the use of these models, especially in Africa. This article demonstrates that the results of several such studies of the impact of trade reforms in Africa differ drastically in terms of both magnitude and direction, failing to take account of key features of African economies. It also outlines potential consequences of the misuse of CGE models for policy evaluation and suggests pitfalls to be avoided.

1. Introduction

Since the Uruguay Round, computable general equilibrium (CGE) models have frequently formed the basis for policy advice and recommendations to developing countries on the potential impact of multilateral trade liberalisation on their economies. Such models allow researchers to provide a quantitative estimate of the potential economic consequences of different trade liberalisation scenarios, including the impact on welfare, trade flows, prices, consumption and production. Because they adopt a multi-sector and multi-region general equilibrium framework, they are also able to capture interactions of different sectors and markets in a given economy and at the international level.[3] This ability to provide a systematic representation of national economies and their links and interactions with the global economy explains their attraction and widespread use for trade policy analysis.

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3 *It should be noted that not all CGE models are multi-region. Country-specific models have also been used to assess the impact of trade liberalisation. See, for example, Stifel and Thorbecke (2003).*

Various global CGE models have been used, including the Global Trade Analysis Project (GTAP) model developed by the Center for Global Trade Analysis at Purdue University (Hertel, 1997); the MIRAGE model developed by CEPII – the Centre d'Etudes Prospectives et d'Informations Internationales (see Bchir et al., 2002); the LINKAGE model of the World Bank (van der Mensbrugghe, 2005); the Michigan model of world production and trade (Deardorff and Stern, 1986); and the G-Cubed model (McKibbin and Wilcoxen, 1992). Clearly, there are differences between these models in terms of structure, assumptions, database and choice of model parameters. In recent years, however, there has been an attempt to minimise the differences through the development of a database from the same source. For example, simulations of the GTAP, LINKAGE and CEPII models are now based on the Market Access Map (MAcMap) dataset developed by CEPII and the International Trade Center (ITC). This has increased the ability to compare results of simulations based on these models.

Although there is a long history of the use of CGE models for policy analysis in developed countries, their use and importance in economic policy analysis and formulation in Africa are relatively recent, increasing since the Uruguay Round. Several factors are behind this development. The first is the increasing acknowledgement by policy-makers of the role and importance of trade in African economies. Unlike in the 1970s, several countries have recognised that trade has an important role to play in the economic development of the continent and are curious to know how various aspects of international trade rules and policies will impact on their economies. The second reason is that African governments are increasingly searching for ways to improve the design of economic policy in the region and have recognised the importance of research as an aid to policy formulation and implementation. This recognition has led to an increase in interest in quantitative techniques that would enhance their ability to evaluate the impact of economic policies on their economies. The third reason is that there has been an improvement in the country coverage of CGE models. For example, unlike in the past, the current GTAP database (version 6) includes 11 countries in sub-Saharan Africa, and this has made it possible to conduct quantitative studies of the impact of trade reforms on these countries. Finally, the use of CGE models in Africa could also be explained by the increasing importance of African countries in multilateral trade negotiations. Before the 1999 WTO Ministerial conference in Seattle, African countries were passive participants; since then, they have played a more proactive role in the negotiations. This has led to an increase in the demand for technical tools to help them define their positions and also assess the impact of the different reform proposals put forward by other WTO members on Africa.

There is no doubt that CGE models can contribute and have contributed to economic policy formulation and analysis (see Devarajan and Robinson, 2005). However, in recent years they have been subjected to serious criticisms (Gunter, Cohen and Lofgren, 2005; Ackerman, 2005; Kehoe, 2003; McKitrick, 1998). This reflects the growing concern about their poor performance and the fact that their results are highly sensitive to the assumptions made – which often do not capture key features of the structure of the economies being analysed. It also reflects the fact that CGE models often have weak econometric foundations. The discomfort is all the greater when it comes to Africa, because there are discrepancies between the results of different CGE simulations even when they are based on models using the same dataset. This has led to some confusion and uncertainty among policy-makers on the possible outcomes of the Doha Round for African countries. Clearly, some of the discrepancies could be explained by the use of different datasets, choice of parameters, and assumptions regarding market structure as well as the functioning of the labour market.

These criticisms raise questions and concerns about the credibility of simulation results from CGE models. This article examines selected but key aspects of the CGE methodology with a view to determining the extent to which they take account of important features of African economies and their implications for trade policy analysis in the region. The article is organised as follows. Section 2 compares the results of major CGE studies that examined the impact of the Doha Round reforms on Africa and shows that the results differ in both the magnitude and the direction of welfare changes. Section 3 focuses on aspects of the CGE methodology. Three are emphasised: the theoretical framework, the database, and the choice of model parameters. Section 4 discusses the need for validation of CGE models and makes suggestions on how this could be done. Section 5 discusses the potential consequences of the misuse of CGE models for policy analysis and formulation in Africa and outlines pitfalls to avoid if they are to be taken seriously by African policy-makers.

2 Africa and CGE Simulation Results

In this section, we present a listing and an analysis of representative studies that provide estimates of the impact of multilateral trade reforms on Africa since the launch of the Doha Round. The list is not exhaustive and is intended to give an idea of the wide range of results that have been obtained from various models (Table 1). The key point to note here is that the estimates vary depending on whether the models are static or dynamic, and also the scenario or experiment performed. They also differ

depending on whether or not the database used takes account of preferences and differences between bound and applied tariffs (often referred to as binding overhang).

The studies by Anderson et al. (2005), Hertel and Keeney (2006), and Achterbosch et al. (2004) examined the impact of full liberalisation of merchandise trade and arrived at the following conclusions. Anderson et al. (2005) suggest that full liberalisation would lead to global gains of $287 billion per year by 2015. They estimate that the gain to sub-Saharan Africa (SSA) would be $4.8 bn (about 1.1% of income). Achterbosch et al. (2004) also report positive welfare gains from full liberalisation for the global economy and SSA, but their numbers are very much smaller than those of Anderson et al. For example, for the global economy they report gains of $84 bn and for SSA their estimate is $704 m. Hertel and Keeney (2006), on the other hand, while estimating similar global gains to those of Achterbosch et al. ($84.3 bn), suggest that the five countries of the Southern African Customs Union (SACU) would derive gains of $1.1bn with the group classified as 'Other SSA' incurring losses of $1.03bn (0.08% of income). It should be noted that Achterbosch et al. also reported losses for SSA from moderate trade reforms, as are likely under the Doha Round. They attribute this to the combined impact of preference erosion and binding overhang.

There are several reasons for these huge discrepancies. First, the Anderson study is based on the LINKAGE model which is dynamic, and we know that dynamic models tend to yield much larger gains than those based on static analysis. Secondly, the Anderson study also uses much larger Armington or trade elasticities than those used in GTAP models. The use of high Armington elasticities reduces the negative terms-of-trade effects associated with reforms and increases welfare gains. When these differences are taken into account, the global gains from the three studies are much closer.

TABLE 1: COMPARISON OF RESULTS OF CGE MODELS

Study/model	Sectors	Reform scenario	Results
WORLD BANK Anderson et al. (2005) • LINKAGE Model (Version 6) (dynamic) • GTAP 6 database (preferences included) • base year 2001	Agriculture Manufacturing	Full liberalisation of merchandise trade over 2005-10	• Global gains of $287 bn p.a. in 2015 • Gain to SSA $4.8 bn (1.1% of income) Static version • Global gain of $127.4 bn • Gain to SSA $0.7 bn GTAP elasticities and land fixed • Global gain $77.8 bn • Loss to SSA is $0.1 bn
Hertel and Keeney (2006) • GTAP-AGR model (static) • GTAP 6 database (preferences included) • base year 2001	Agriculture Manufacturing Services	Full liberalisation of merchandise trade	Merchandise trade liberalisation • Global gain $84.3 bn • SACU gains $1.1 bn • Loss to the group 'Other SSA' $1.03 bn (0.8 % of income) Agriculture liberalisation • Global gains $55 bn • SACU gains $529 m. • group 'Other SSA' incurs $167 m. loss
CARNEGIE Polaski (2006) • GTAP Model (static) • GTAP 6 database (preferences included) • base year 2001 • incorporates unemployment in developing countries	Agriculture Manufacturing	Full liberalisation and partial reforms reflecting plausible Doha Round scenarios	Full liberalisation • Global gain $168.1 bn (0.5% of GDP) Doha scenarios • Global gain $59 bn • East Africa will lose about $0.1 bn and 'Rest of SSA' $0.2 bn.
OECD Lippoldt and Kowalski (2005) • GTAP Model (static) • GTAP 6 database (preferences included) • base year 2001	Agriculture Manufacturing	50% cut in ad-valorem equivalent measures of tariff protection	• 0.16% change in per capita welfare for 'Rest of SSA'
IFPRI Diao et al. (2005) • Static CGE model • Variable employment • GTAP 5 database • base year 1997	Agriculture	Full liberalisation of agricultural trade	• Gain to SSA $1.2 bn • With productivity effects gain is $1.7bn • GDP expands in SSA by $1.7 bn and $2.1 bn with productivity effects

UNECA/LEI Achterbosch et al. (2004) • GTAP model (static and dynamic) • GTAP 5 database with tariffs adjusted for preferences and binding overhang • variable employment	Agriculture Manufacturing	Full liberalisation Moderate reform involving 50% reduction in all forms of protection	• Global gains $84 bn (0.3% of income) • Gain to SSA $704 m. (0.3% of income) Moderate reform • Global gains $40 bn (0.1% of income) • Loss to SSA $502 m. (0.2% of income)
CEPII Bouet et al. (2004) • MIRAGE model (static) • Imperfect competition in nonagricultural sector • Dual labour markets (efficiency wages) • MAcMap database (preferences included) • base year 2001	Agriculture	50% cut in domestic support, elimination of export subsidies, 40% cut in small tariffs (<15%), and 60% cut in high tariffs (>90%)	• Global gains 0.08% of income • Loss to SSA 0.03% of income
UNECA Ben Hammouda et al. (2005) • GTAP model (static) • GTAP 5 Database	Agriculture	Scenario 1: 3 bands for tariff reduction in developed countries. 40% for tariffs less than 15%; 50% for tariffs (15-90%); and 60% for tariffs greater than 90%. 4 bands for tariff reduction in developing countries If tariff is in range (0 < 20%) apply 25%. In range (20 < 60%) apply 30%. For (60 < 120%) apply 35% and for (>120%) apply 40% 50% reduction in domestic support and complete elimination of export subsidies Scenario 2: same as scenario 1 but with 5% of tariff lines in developed countries treated as Sensitive Products	Scenario 1 • Gains to SSA $943 m. and for North Africa $2.4 bn • GDP expands by 0.47% in SSA and by 1.47% in North Africa Scenario 2 • Gains to SSA $977 m. and for North Africa $2.47 bn • GDP expands by 0.41% in SSA and by 1.51% in North Africa
UNECA Sadni-Jallab et al. (2005) • GTAP model (static) • GTAP 6 Database (preferences included)	Manufacturing	Scenario 1: Girard Formula used for tariff reduction with the B coefficient set at 1 for all countries. For developing countries 5% of tariff lines excluded. Also for 10% of tariff lines in developing countries, only 50% reduction specified by Girard formula applied. Scenario 2: Same as in scenario 1 but with B equal to 3	Scenario 1 • Gains to SSA $489 m. and for North Africa $3.5 bn • GDP expands by 0.37% in SSA and by 1.7% in North Africa Scenario 2 • Gains to SSA $337 m. and for North Africa $2.79 bn • GDP expands by 0.21% in SSA and by 1.28% in North Africa

The study by Polaski (2006) found that full liberalisation of merchandise trade would increase global welfare by $168.1 bn. It also showed that, with plausible Doha Round reform scenarios, East Africa and the group 'Rest of SSA' would incur losses of $0.1 bn and $0.2 bn respectively. This is attributed to preference erosion, low agricultural productivity and lack of export competitiveness. What is striking about Polaski's findings is that the welfare gains she reports are larger than those of researchers using similar GTAP models and databases and it is not clear what accounts for these huge differences in results (see for example, Hertel and Keeney, 2006).

Lippoldt and Kowalski (2005) also focused on liberalisation of merchandise trade. However, they considered the impact of a 50% cut in ad-valorem equivalent measures of tariff protection. The key result of their study is that there will be a 0.16% decrease in per capita welfare for the group 'Rest of SSA' as a result of this type of reform. This is attributed to preference erosion.

Three of the studies listed in Table 1 focused on liberalisation of agricultural trade. Diao et al. (2005) examined the impact of its full liberalisation. Their results suggest that the welfare benefits to SSA are $1.2 bn and that output (GDP) in the region will expand by $1.7 bn. Ben Hammouda et al. (2005) focused on the impact of partial liberalisation of agricultural trade. Their results suggest that, if there are no exemptions for Sensitive Products, partial liberalisation will increase welfare in SSA by $2.4 bn and in North Africa by $943 m., with output expanding by 0.47% in SSA and by 1.47% in North Africa. Bouet et al. (2004) also examined the effect of another type of partial agricultural trade liberalisation. They estimate that this will increase global welfare by 0.08% of income but that SSA will incur losses equivalent to 0.03% of income.

Although these three studies examined agricultural trade liberalisation, they focused on different scenarios of reforms with varying degrees of ambition, and it is therefore difficult to compare the results to find out what is responsible for the differences. Having said that, it appears that the welfare loss estimated for SSA by Bouet et al. arises from the fact that their model takes account of preference erosion, which is absent in the other two studies.

The article by Sadni-jallab et al. (2005) deals with the impact of liberalisation of trade in manufactured goods on Africa. It assumes that tariff reduction will be accomplished using the Girard Formula and examines how Africa will be affected by the use of different coefficients and considerations for Special and Differential Treatment. The key result is that in the first scenario SSA gains by $489 m. and North Africa by $3.5 bn. In addition, the study suggests that output (GDP) in SSA will expand by 0.37% and in North Africa by 1.7%.

What can be inferred from these results as well as others in the literature? In summary, our reading of the results of simulation experiments examining the potential impact of multilateral trade reforms is as follows.

- there are global gains to be derived from multilateral trade liberalisation, the precise magnitude of which depends on the nature and degree of liberalisation as well as the sectors covered;
- agricultural trade liberalisation is expected to account for a substantial share of the gains from multilateral trade liberalisation;
- of the three pillars identified in the Doha Round negotiations on agriculture – domestic support, market access and export competition – market access seems to be the most important source of gains from agricultural trade liberalisation;
- there are bound to be winners and losers. Whether or not a country derives benefits would depend on the extent to which it relies on trade tax revenue, the type of goods it exports, and its ability to respond to potential market opportunities to be created by liberalisation. More specifically, countries that are net food importers after reform as well as those that face severe supply constraints are likely to incur welfare losses. In this regard, African countries are highly vulnerable to reforms;
- preference erosion is also important in determining gains and losses. Countries that benefit from preferences are likely to incur losses from liberalisation if the nature of the reform is such that they are exposed to competition in markets where they receive preferences but do not gain additional market access in other countries to compensate for the loss.

3 Features of African Economies and the CGE Methodology

This section highlights issues that need to be addressed in the design of CGE models so that they can capture important features and dynamics of African economies and increase the likelihood of obtaining realistic results from the simulations. For ease of exposition, our analysis will focus on three areas: the theoretical framework or structure of the models; the database used in simulations and calibration; and the choice of key model parameters.

3.1 Theoretical Issues

Most CGE models of trade introduce product differentiation by assuming that imports and domestic goods are imperfect substitutes in demand. This follows the work of Armington (1969) and has the implication that each country or firm is the sole supplier of its products and so can affect the price of the product. Clearly, the assumption that countries are large enough to affect the market price of their exports is at variance with what we know about African economies. With the exception of a few products and countries (such as cocoa exported by Ghana and Côte d'Ivoire, bauxite exported by Guinea, and groundnut oil exported by Senegal), most African exports represent only a small fraction of world exports and so cannot affect world prices. The large-country assumption implicit in the Armington structure of CGE models does not reflect African realities and has serious implications for the impact of trade liberalisation on economies in the region, since it is well known that results of CGE models are very sensitive to the Armington assumption and parameters (Valenzuela et al., 2006). Consequently, there is the need for CGE modellers to revisit this assumption to capture more accurately the features of African economies.

Trade negotiation is a bargaining game and so the power relations among countries as well as the nature of interactions and the availability of information affect its outcome. Strategic behaviour among countries and agents is completely ignored in CGE models of trade policy and multilateral negotiations. This is particularly important, given the lop-sided power structure between countries in the WTO. Clearly big countries or groups such as the US and the European Union are in a better position to influence the agenda and pace of the negotiations and this has serious implications for the outcome (Osakwe, 2007). Models of game theory have emphasised the importance of first-mover advantages in negotiations, and to the extent that big countries control the manner in which the

negotiations are conducted, it has serious consequences for the ability of weak African nations to protect their interests (Myerson, 1991; Brander and Spencer, 1992). These issues therefore need to be taken into account if the true impact of multilateral trade reforms on African countries is to be captured.

The role and importance of market imperfections in determining macroeconomic outcomes in modern economies have been recognised in the economics literature and several models of trade now incorporate market imperfection and scale economies (Francois, 1998; Grossman, 1992). Although some CGE models incorporate market imperfection, the main motivation for this is the need to generate intra-industry trade, especially in the manufacturing sector. This focus has led to the neglect of other forms of market imperfections such as those in the input and credit markets of developing countries. For example, consumers and producers in these countries face severe borrowing constraints and this limits their ability to be effective participants in the market economy (Eswaran and Kotwal, 1990; Ray, 1998). These constraints are particularly serious in rural communities where peasants have limited or no access to the banking system. It is also one of the reasons for interlocking factor markets in several developing countries (Bardhan and Rudra 1978; Goetz 1993). These market imperfections have serious implications for the ability of firms and countries to take advantage of potential trading opportunities created in the multilateral trading system and should be taken into account in the modelling exercises. The presumed economic benefits of free trade are unlikely to be realised in developing countries if product markets are liberalised without addressing input-market imperfections.

One of the key assumptions made in CGE models is that trade liberalisation has no impact on government revenue. This is typically implemented by altering domestic taxes in response to changes in trade tax revenue so as to leave total government revenue unchanged after trade reforms. While this may be analytically convenient, it raises two issues or problems. The first is that it is based on the unrealistic assumption that governments can fully recover lost tariff revenue by switching to domestic taxes. Recent empirical evidence shows that poor countries that adopted trade reforms failed to recover most of the lost revenue by switching to domestic taxes (Baunsgaard and Keen, 2005; Khattry and Mohan Rao, 2002). Emran and Stiglitz (2005) provide theoretical explanations for this result.

The second problem with the treatment of the revenue effects of trade reform is that it is typically assumed that trade taxes (which are distortionary) will be replaced with lump-sum taxes. To the extent that these are non-distortionary and do not reflect the kinds of taxes that can be imposed by African governments, this assumption overstates the welfare gains to the region from liberalisation. Osakwe (2007) shows that African countries are heavily dependent on trade taxes. For example, in countries such as Benin, Lesotho, Madagascar, Mali, Sierra Leone, Togo and Uganda trade taxes represented more than 40% of government revenue over the 2000-3 period. Given this degree of dependence, any realistic assessment of the impact of multilateral trade reforms on Africa has to take account of the impact on government revenue. Assuming tax neutrality trivialises an important issue of concern to African countries in the negotiations.

It is well-known in the economics literature that there are short-run costs associated with trade liberalisation (Laird and Fernandez de Cordoba, 2005). However, CGE models do not take adjustment costs into account. This arises partly from the fact that most of the models tend to be static and assume flexible prices and full employment of labour. In a static model it is not possible to model the process of adjustment to trade reform and so the costs of the adjustment process cannot be taken into account. In addition, the full employment assumption in most CGE models is problematic because it is inconsistent with empirical evidence and also does not allow researchers to ask important questions such as how the reform process would impact on unemployment (Polaski, 2006; Gunter, Taylor and Yeldan, 2005). The assumption of full employment trivialises this question because, in a market-clearing world, trade liberalisation simply leads to reallocation of existing labour across sectors and the short-run adjustment costs would therefore be insignificant. On the other hand, in economies characterised by high unemployment, the reallocation may involve some people moving from employment to unemployment and so the adjustment costs will be higher.

Recently, attempts have been made to make employment variable in GTAP models by fixing the nominal or real wage. While this is an improvement on the fullemployment assumption, it is not an appropriate way to take account of unemployment in developing countries because it does not capture the process of wage determination in these countries. There are several ways to introduce unemployment endogenously in the literature that could be adapted to capture this phenomenon. This includes efficiency wages and labour turnover models which have been used by several authors in the economics literature (Stiglitz, 1974; Swamy, 1997).

Most CGE models of trade are deterministic and so do not address issues related to risk and uncertainty. However, one of the key concerns of African countries in the negotiations is that liberalisation would expose them to external shocks, thereby increasing the volatility of macroeconomic variables with potential consequences for growth and development. African

countries are vulnerable to trade shocks because they export a relatively small number of products with very volatile prices. To the extent that liberalisation increases their exposure to risks, this should to be taken into account in the models as it will definitely affect welfare changes to African countries in the model.

3.2 Database Issues

The availability of a high-quality and comprehensive dataset is crucial to CGE analysis. Therefore, if the database used for simulation experiments does not accurately capture the current structure of economies, it is difficult to have confidence in the results of the analysis. In the past, researchers used datasets from different sources and this was in part responsible for some of the discrepancies in the results of CGE simulations of trade liberalisation. Currently, most of the key CGE models are run using the MAcMap dataset developed by CEPII. For example, version 6 of both the GTAP and LINKAGE models uses a database based on information from this source. There are, however, several problems with the GTAP 6 database that make it difficult to get a realistic assessment of the impact of multilateral trade liberalisation on African economies.

The first is that, due to data limitations, only a few African countries are included in the database. For example, in the GTAP 6 database only 11 of the 48 countries in sub-Saharan Africa are included.[4] The other countries in the region are classified into the composite group 'Rest of SSA'. This level of aggregation does not recognise the heterogeneity among African countries and does not permit researchers to measure the impact of trade liberalisation or the WTO negotiations at the national level. This is a major issue for African countries because there is a wide diversity among them. For example, several are net food-importing countries while others are net food exporters (Osakwe, 2007). Similarly, some are net oil exporters and others net oil importers. This high heterogeneity implies that we should be cautious in making general statements about the impact of reforms on African countries since aggregate results can be quite misleading.

Related to the above point is the fact that most of the commodities exported by African countries are not sectors in the GTAP database, but are aggregated and lumped into much larger sectors. For example, coffee and cocoa as well as other commodities with very different production structures and price dynamics are included together in the composite sector 'Crops nec'. Valenzuela et al. (2006) show that product aggregation is important in determining the estimated gains from trade reform. Deaton (1999) also points out that supply conditions differ across commodities. Furthermore, their prices do not move in parallel and relative prices are not constant. Given the heterogeneity among commodities lumped together, it is difficult to get a realistic assessment of the impact of trade liberalisation on the key commodities of interest to African countries.

The third problem with the GTAP 6 database is that the measures of protection reported for African countries in the database seem to be different from those computed directly using the MAcMaP dataset. Table 2 shows tariffs applied to the GTAP groups 'Rest of SSA' and 'Rest of North Africa' by the EU25 based on the GTAP 6 database and on MAcMAP, showing that the GTAP tariffs are much lower than those computed directly from the HS6 level. The aggregation method is clearly responsible for this huge discrepancy. Generally, tariff data are computed from countries' official notifications to the WTO. In MAcMAP, data from these notifications are aggregated at the HS6 level. The product of this first-level aggregation is then used by the different researchers and models to build their own database.

This usually involves aggregation at a second level which drastically reduces the number of sectors available in the database.[5] The most widely used method of aggregation is the trade-weighted method. However, this method underestimates the tariffs facing African countries because it implicitly assumes that protection is zero for tariff lines where trade does not occur between two countries. As a result of the problems with the trade-weighted approach, there has been a shift towards using a 'reference group' methodology where the imports of a reference group, rather than those of an individual country in the group, are used as weights. Statistics on trade openness and GDP per capita (calculated on the basis of purchasing power parity) are used to classify countries into reference groups. This new methodology has led to an improvement in the database, although it has not eliminated the difference in the tariff structure between GTAP 6 and MAcMAP. There is therefore a need to revisit the methods of aggregation to make sure that the database, and especially the tariff structure, reflects the real tariffs that African countries are facing.

Another data-related problem is that there are large differences between the tax rates used in GTAP and those based on tax receipts. It is difficult to find reliable data on actual tax rates in several African countries and so we demonstrate this discrepancy from data for advanced countries. Using

4 *These countries are : South Africa, Botswana, Malawi, Mozambique, Tanzania, Zambia, Zimbabwe, Madagascar, Uganda, Tunisia and Morocco. The Economic Commission for Africa and the African Trade Policy Center are working closely with GTAP to introduce more African countries.*

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TABLE 2: EU 25 TARIFFS APPLIED TO GTAP GROUPS, 'REST OF SSA' AND 'REST OF NORTH AFRICA'

Sector	Code	MAcMAP (direct aggregation)	GTAP 6
Rest of SSA			
Dairy products	mil	39.0	13.4
Processed rice	pcr	31.5	14.1
Cereal grains nec	gro	21.1	3.4
Beverages and tobacco products	b_t	14.4	9.1
Paddy rice	pdr	12.0	0
Sugar cane, sugar beet	c_b	7.5	0.9
Meat products nec	omt	6.0	4.4
Wheat	wht	5.9	0.1
Food products nec	ofd	3.4	1.6
Cattle, sheep, goats, horses	ctl	2.3	0.5
Ferrous metals	i_s	2.2	1.8
Wearing apparel	wap	1.5	0.5
Textiles	tex	1.3	0.5
Gas manufacture. distribution	gdt	1.1	0
Rest of North Africa			
Dairy products	mil	42.3	14.7
Vegetable oils and fats	vol	34.2	31.5
Meat products nec	omt	22.2	2.7
Cereal grains nec	gro	16.2	7.5
Cattle, sheep, goats, horses	ctl	14.6	9.8
Beverages and tobacco products	b_t	14.4	11.2
Vegetables. fruit. nuts	v_f	12.4	11.9

TABLE 3: COMPARISON OF TAX RATES FOR 2001 (%)

	Consumption			Labour		Capital		Land	Natural resources
Country									
	GMR	GTAP6 domestic	GTAP6 imports	GMR	GTAP6	GMR	GTAP6	GTAP6	GTAP6
Denmark	36.1	25.2	16.1	52.1	5.2	46.6	1.7	-61.6	2.0
Finland	27.3	26.9	26.3	49.5	8.4	36.0	0.0	-75.9	0.8
France	18.2	11.6	24.6	45.4	79.5	38.4	2.5	-64.3	3.0
Germany	15.5	13.2	14.1	41.8	45.7	21.5	0.8	-62.6	1.0
Britain	15.7	2.0	0.9	28.0	18.1	54.1	4.0	-58.0	4.4
Italy	15.1	11.4	19.6	45.5	44.1	34.4	0.5	-51.4	0.8
Japan	6.9	4.3	4.7	28.4	18.8	40.4	3.3	-8.5	3.3
Netherlands	21.0	2.8	14.3	41.6	64.0	34.5	1.9	-21.6	2.3
Spain	14.2	3.5	0.8	29.3	34.3	22.4	1.5	-54.4	2.2
Sweden	26.0	17.5	14.4	56.6	40.8	50.4	1.7	-79.7	2.0
US	4.7	0.4	1.0	29.5	15.9	36.0	3.0	-34.5	3.0

Source: Gurgel et al. (2006).

OECD data, Gurgel et al. (2006) show that the tax rates used in the GTAP database are quite different from those computed based on reported tax receipts. They also suggest that these differences cannot be attributed to the method of aggregation. Table 3 presents tax rates computed for selected countries using this approach (GMR method) and those in GTAP 6, showing large differences. For example, based on GTAP 6 labour tax in Denmark is 5.2%, while the GMR method suggests it is 52.1%. The discrepancies are even greater with capital taxes. Differences of this magnitude will certainly affect the outcome of any simulation experiment and efforts should therefore be made to reconcile these differences.

3.3 Behavioural Parameters

One of the key drivers of CGE model results is the choice of parameters. There are two key parameters in these models, the first representing share parameters such as consumer expenditure shares, and import and export shares, and government expenditure shares, and the second the structural parameters which are basically elasticities describing the curvature of production, utility, import-demand and exportsupply functions. Despite the importance of these parameters, they are rarely estimated by CGE researchers, who either make choices of these parameters based on subjective judgements or take them from econometric estimates obtained using data not related to the period covered by their simulation experiments (FAO, 2005). Furthermore, in some instances the estimates are based on studies more than a decade old and so do not reflect the current structure of the economies under consideration.

Liu et al. (2003) have tried to address this concern by updating estimates used for the GTAP model. Their analysis suggests that elasticities used in previous versions of GTAP tend to be too small for processed food, motor vehicles and electronic machinery. In addition, they tend to be too large for agriculture, clothing and textile products, fuels and minerals, and basic manufactures (see Table 4). This is an interesting finding because it indicates that the sectors of export interest to African countries are precisely those in which the current elasticities are too high. This has implications for the impact of trade reforms on Africa, since high trade elasticities tend to lead to higher welfare gains. The high degree of uncertainty surrounding estimates of these key parameters suggests that we should be careful about making firm and unqualified statements regarding the impact of multilateral trade reforms on economies.

4 Validation of CGE Models

Models are in general an abstraction from reality in the sense that they usually cannot capture all aspects and features of modern economies. Despite this abstraction, they can sharpen our understanding of reality by providing important insights into the functioning of the complex economic environment in which we live. For a model to play this role, however, it has to be designed in such a way that it reflects important aspects of the economy and phenomena under investigation. In particular, the ability of a model to make realistic predictions is likely to be higher if its key results are not dependent on subjective assumptions about the economic environment. In designing economic models for use in policy formulation it is therefore important that researchers make simplifying assumptions that are either grounded in reality or do not have any significant impact on the results.

In recent years, there has been a proliferation of models for global trade-policy analysis. These differ in terms of structure and often give different answers to the same questions. This is a source of confusion for policymakers, especially in developing countries where there is lack of adequate analytical capacity to evaluate the results of these studies. In such an environment there is the need for a rigorous method for assessing the validity of these models and their predictions. One of the most serious criticisms

TABLE 4: CURRENT AND ESTIMATED TRADE ELASTICITIES

Industry	GTAP	New Estimate
Agriculture (AGR)	2.44	1.05
Processed food (PAG)	2.40	3.76
Fuels and Minerals (FMN)	2.41	1.08
Clothing and textile (CTX)	3.32	2.54
Light manufactures (OLT)	2.15	2.23
Chemicals (CHM)	1.90	1.98
Motor vehicles and electronic machinery (MEV)	3.10	3.66
Basic manufactures (BAM)	3.47	2.24

Source: Liu et al. (2003).

of CGE trade models is the lack of validation of the models' predictions (Kraev and Akolgo, 2005). In other words, there is no way to tell whether or not the predictions match actual events based on historical data. CGE researchers typically respond to this criticism by stating that ex-post validation of their model is difficult because the income gains reported are measures of social welfare which are unobservable. They also argue that events outside the domain of the model affect or influence the actual behaviour of the global economy and so it would be inappropriate to expect the model's predictions to match historical data (see for example, Whalley, 2000). While these are valid arguments, they also apply to modelling methods used by the Real Business Cycle (RBC) researchers but have not prevented the validation of RBC models.

Kehoe (2003) presents one example of an approach that could be used to validate CGE model predictions. It involves looking at historical data, sorting out stylised facts about the economies under investigation, and then comparing the models' predictions on key macroeconomic variables with those in the data. For example, one can take a CGE model that was used to examine the impact of the Uruguay Round reforms and then run the simulations using only those reforms that have taken place so far and compare the results on changes in key variables with the actual changes we have observed. Valenzuela et al. (2005) suggest a similar but less comprehensive approach to model validation based on replicating observed price volatility in agricultural markets. They applied this to the GTAP model and found that it performs reasonably well for some countries (for example, Canada and Australia) and less so for others. In particular, the model tends to under-predict price volatility for net exporters and over-predict volatility for importing regions. They argue that the incomplete transmission of world price signals into domestic markets is responsible for this result, and that when this is taken into account the model does quite well. These validation efforts are welcome; they will ensure that CGE models capture certain facts about the trading system and increase the credibility of their results.

5 Risks, Challenges and Way Forward

Several African countries lack adequate research capacity to conduct analytical studies on key issues of interest to them in multilateral and regional trade negotiations, and so they often rely on the results of research carried out by international institutions and academics. When researchers present results that differ significantly in terms of both direction and magnitude, and there is no explanation as to why these discrepancies occur, policy-makers find themselves in a very difficult situation because they do not know how seriously to take the results. In particular, they do not know which of the studies is more accurate and relevant to their situation. Unlike academics and developed-country policy-makers who have many trade professionals to deal with technical issues, African policy-makers are often not in a position to evaluate these studies to determine how credible they are and how useful as bases for policy formulation. This can lead to one of two unattractive responses by African policymakers:

(i) They may use the results of these studies for policy formulation even when they are not based on realistic assessments of the structure of their economies. This leads to wrong policy choices and has consequences for the ability of African countries to meet the development challenges facing them.

(ii) They may completely disregard results and recommendations from these studies in policy formulation and base their judgment on political realities and popular attitudes towards trade reform. While this is understandable, it could also lead to wrong policy choices.

Researchers therefore have a responsibility to ensure that policy recommendations are made on the basis of sound and objective assessment of the issues under investigation so that CGE models would be seen as an aid to policy formulation rather than a source of confusion to policy-makers. Clearly, CGE models have an important role to play in economic policy formulation in Africa. When based on a sound theoretical framework, realistic assumptions and objective choice of parameters, they can provide policy-makers with very useful insights into the functioning of their economies as well as forming the basis for advice on the positions countries should adopt in multilateral trade negotiations. African countries should continue to pay attention to CGE models of trade policy but should not base their policy decisions solely on the results of existing models, since they do not take into account important features of their economies and there is so much uncertainty surrounding the parameter estimates used for the simulations. Combining the results of CGE models with those based on other frameworks will provide a better guide to policy decisions and minimise the risks of policy errors.

There is a tendency for researchers to make recommendations to policy-makers based on the results of CGE models with very weak econometric foundations, and this increases the propensity for decision-makers to make wrong policy choices. Given that African countries have very limited resources to address the enormous development challenges facing them, the cost of failures of this sort is very high. There is therefore the need for caution in the use of model results for policy decisions in the region (Gunter, Cohen and Lofgren, 2005).

The credibility of CGE models will improve if researchers using the CGE methodology adopt and follow simple rules and principles. The first is to avoid the temptation to design experiments and choice of parameters to yield results that justify predetermined views on trade policy. The second is to exercise caution in the interpretation of simulation results to avoid sending the wrong message to policymakers. For example, with most of the results from GTAP simulations referring to the aggregate group 'Rest of Sub-Saharan Africa', simulation results suggesting welfare gains for the group are often interpreted as evidence that SSA would benefit from reform. However, given the wide diversity of countries in the group, one cannot rule out the possibility that a number of countries in the group would incur losses. There is therefore the need to exercise caution in the leap from simulation results to policy recommendations.

The third step CGE researchers should take to increase the credibility of their model is to put less emphasis on the welfare results of CGE models and more focus on inter-sectoral and inter-country changes and shifts in resources resulting from trade reforms. Finally, there is the need for a more transparent way of disseminating the results of CGE models. In particular, authors should outline the key features of their model that are important for the results. They should also specify the choice of the key model parameters as well as providing justifications for them. This type of transparency will ensure that results can be reproduced by other researchers and will make comparisons and interpretation of results much easier.

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