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Abstract

Computable general equilibrium (CGE) models are widely used for trade policy analyses and recommendations. Simulation results from these models have also been used as a basis for offering advice to African countries on what positions to take in multilateral trade negotiations. There is however increasing discomfort with the use of these models for policy recommendations, especially in Africa. In this paper we compare the results of several CGE studies that examined the impact of potential Doha Round reforms on Africa and demonstrate that the results differ drastically both in terms of magnitude and direction. Part of the discrepancies in results can be explained by differences in database, model structure, and choice of parameters. Others are, however, difficult to explain because several studies either do not report key assumptions made or do not provide a clear description of how their framework differs from those in the literature. We also show that the modelling approach and the database used in most CGE studies do not take account of key features of African economies that have serious implications for the impact of trade reforms on Africa. Finally, we outline potential consequences of the misuse of CGE models for policy evaluation and suggest pitfalls to avoid if CGE model results are to be taken seriously by policy makers in Africa.

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I. Introduction

Computable general equilibrium (CGE) models are frequently used for economic policy analysis and, since the Uruguay Round, have formed the basis for policy advice and recommendations to developing countries on the potential impact of multilateral trade liberalization on their economies. CGE models of trade allow researchers to provide a quantitative estimate of the potential economic consequences of different trade liberalization scenarios. This includes the impact on welfare, trade flows, prices, consumption and production. Because CGE models 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. This ability of CGE models 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.

Various global CGE models have been used for trade policy analysis. These include: 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, Decreux, Guérin and Jean 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 minimize the differences between these models 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 advanced countries, its use and importance in economic policy analysis and policy formulation in Africa is relatively recent. Since the 1990s there has been an increase in the use of these models for trade policy analysis in the region. Several factors are behind this development. The first is the increasing acknowledgement by policymakers 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 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 increase their ability to evaluate the impact of economic

policies on African economies. The third reason for the increase in use of CGE models in Africa 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 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 in multilateral trade negotiations. 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 African countries define their positions and also assess the impact of the different reform proposals made by other WTO members on Africa.

There is no doubt that CGE models can 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 (Ackerman 2005; Kehoe 2003; McKitrick 1998). This reflects the growing concern about the poor performance of these models and the fact that their results are highly sensitive to the assumptions made---which often do not capture key features of the structure of economies being analysed. It also reflects the fact that CGE models often have weak econometric foundations. The discomfort with results of CGE models is 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. These differences are observed both in terms of the magnitude and direction of welfare changes. This has led to some confusion and uncertainty among policymakers on the possible outcomes of the Doha Round for African countries. Clearly, some of the discrepancies in the results 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 paper 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 paper is organized as follows. Section II compares the results of major CGE studies that examined the impact of the Doha Round Reforms on Africa and shows that the results differ both in the magnitude and direction of welfare changes. Section III focuses on aspects of the CGE methodology that do not reflect features as well as the structure and functioning of African economies. Three aspects of this methodology are emphasized: the theoretical framework; the database; and the choice of model parameters. Section IV discusses the need for validation of CGE models and makes suggestions on how this could be done. Section V discusses the potential consequences of the misuse of CGE models for policy analysis and formulation in Africa and outlines pitfalls to avoid in the use of CGE models if they are to be taken seriously by African policy makers.

II. Africa and CGE Simulation Results

Since the launch of the Doha Round in 2001, several studies have been carried out to examine the impact of potential multilateral trade reforms on Africa and the global economy. 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. The list is not exhaustive and is intended to give an idea of the wide range of results that have been obtained by researchers using various trade models. Table 1 presents a listing of the predicted impact of trade reforms on Africa obtained from these studies. The key point to note here is that the estimates vary depending on whether the models are static or dynamic, take preferences into account, and 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 liberalization of merchandise trade and arrived at the following conclusions. Anderson et al (2005) suggest that full liberalization of merchandise trade would lead to global gains of $287 billion per year in 2015. They estimate that the gain to Sub-Saharan Africa (SSA) is $4.8 billion (which is about 1.1% of income). Achterbosch et al (2004) also report positive welfare gains from full merchandise trade liberalization for the global economy and SSA. However, their numbers are very much smaller than those of Anderson et al (2005). For example, for the global economy they report gains of $84 billion and for SSA their estimate is $704 million. Hertel and Keeney (2006) on the other hand estimate that the global gains are $84.3 billion which is the same as in the study by Achterbosch et al (2004). However, for Africa their results suggest that the five countries of the Southern African Customs Union (SACU) would derive gains of $1.1 billion while the group classified as "Other SSA" incurs losses of $1.03 billion (0.08% of income). It should be noted that Achterbosch et al (2004) also reported losses for SSA from moderate trade reforms as is likely under the Doha Round. They attribute this to the combined impact of preference erosion and binding overhang.

There are several reasons for the huge discrepancies between the results of Anderson et al (2005) and those of Hertel and Keeney (2006) and Achterbosch et al (2004). The first is that 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. The second is that the Anderson et al 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 accounted for the global gains from the three studies are much closer.

The study by Polaski (2006) found that full liberalization of merchandise trade would increase global welfare by $168.1 billion. It also showed that for plausible Doha Round reform scenarios, East Africa and the group "Rest of SSA" would incur losses of $0.1 billion and $0.2 billion respectively. This is attributed to preference erosion, low agricultural productivity and lack of export competitiveness. What is striking about the finding by Polaski is that the welfare gains reported in her study are larger than those of researchers using similar GTAP models and database 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 liberalization of merchandise trade. However, they considered the impact of a 50% cut in ad-valorem equivalent measures of tariff protection. The key result of the 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 liberalization of agricultural trade. Diao et al (2005) examined the impact of full liberalization of agricultural trade. Their results suggest that the welfare benefits to SSA are $1.2 billion and that output (GDP) in the region will expand by $1.7 billion. Ben Hammouda et al (2005) examined the impact of agricultural trade liberalization although their study focused on partial liberalization. Their results suggest that if there are no exemptions for Sensitive Products, partial liberalization of agricultural trade will increase welfare in SSA by $2.4 billion and in North Africa by $943 million. Their results also suggest that output will expand 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 liberalization. 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 focused on agricultural trade liberalization, they focused on different scenarios of reforms with varying degrees of ambition and so it is 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 in the study by Bouet et al (2004) arises from the fact that their model takes account of preference erosion which is absent in the other two papers.

The paper by Sadni-jallab et al (2005) deals with the impact of liberalization 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 million and North Africa by $3.5 billion. 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 liberalization. The precise magnitude of this gain depends on the nature and degree of liberalization as well as the sectors covered;

- Agricultural trade liberalization is expected to account for a substantial share of the gains from multilateral trade liberalization;

- Within the agriculture sector, out of the three pillars market access seems to be the most important source of gains from liberalization;

- There are bound to be winners and losers. Whether or not a country derives positive 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 liberalization. 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 liberalization if the nature of 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.

III. 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.

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 Ivory Coast; bauxite exported by Guinea; and groundnut oil exported by Senegal), exports of most African countries represent only a small fraction of world exports and so they cannot affect the world prices of their exports. 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 liberalization 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, Anderson and Hertel 2006). Consequently, there is the need for CGE modelers to revisit this assumption to capture more accurately the feature 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 the outcome of the game. 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 United States (US) and the European Union (EU) are in a better position to influence the agenda and pace of the negotiations and this has serious implications for the outcome of the negotiations (Osakwe 2006). Models of game theory have emphasized 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). Therefore these issues need to be taken into account if they are to capture the true impact of multilateral trade reforms on African countries.

The role and importance of market imperfections in determining macroeconomic outcomes in modern economies has been recognized 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 in CGE models 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 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 modeling exercises. The presumed economic benefits of free trade are unlikely to be realized in developing countries if product markets are liberalized without addressing input market imperfections.

One of the key assumptions made in CGE models is that trade liberalization 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 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 lump-sum taxes 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 liberalization. Osakwe (2006) 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 percent of government revenue over the 2000-2003 period. Given this degree of dependence on trade tax revenue, 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 trivializes 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 liberalization (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 for labour 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). The assumption of full employment of labour trivializes this question because in a market clearing world, trade liberalization simply leads to reallocation of existing labour across sectors and so the short-run adjustment costs would be insignificant. On the other hand, in economies characterized 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 through fixing the nominal or real wage. While this is an improvement over the full employment 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 liberalization 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 liberalization increases their exposure to risks, this ought to be taken into account in the models as they will definitely affect welfare changes to African countries in the model.

Database Issues

The availability of 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 liberalization. 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 use a database developed 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 liberalization 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 in the database[1]. 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 countries in the region. For example, several countries are net food importing countries while others are net food exporters (Osakwe 2006). Similarly, some are net oil exporters and others are 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. They are aggregated and lumped into much larger sectors. For example, coffee and cocoa as well as other commodities with very different production structure and price dynamics are included together in the composite sector "Crops nec." Valenzuela, Anderson and Hertel (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 constan. Given the heterogeneity among commodities lumped together, it is difficult to get a realistic assessment of the impact of trade liberalization 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. Tables 2 and 3 show tariffs applied to the GTAP groups "Rest of SSA" and "Rest of North Africa" by the EU25 based on the GTAP 6 database and those based on MAcMAP. The table shows that the GTAP tariffs are much lower than those computed directly from the HS6 level using the MAcMAP dataset. The aggregation method is clearly responsible for this huge discrepancy. Generally, tariff data are computed from the official notifications made by the countries 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 reduces drastically the number of sectors available in the database[2]. 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

1. 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 in the database.
2. In GTAP for example we have 57 sectors.

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 structure of the tariffs 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 in 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 using data for advanced countries. Using OECD data, Gurgel, Metcalf and Reilly (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 4 presents tax rates computed for selected countries using this approach (GMR method) and those in GTAP 6. Clearly, there are large differences in rates reported by the two methods. 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 so efforts should be made to reconcile these differences.

Behavioural Parameters

One of the key drivers of results of CGE models is the choice of parameters. There are two key parameters in these models. The first represents share parameters such as consumer expenditure shares, import and export shares, and government expenditure shares. The second is the structural parameters which are basically elasticities describing the curvature of production, utility, import demand and export supply functions. Despite the importance of these parameters, they are rarely estimated by CGE researchers. They 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 that are more than a decade old and so do not reflect the current structure of the economies under considerations. Liu, Arndt and Hertel (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 and 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 5). 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 strong and unqualified statements regarding the impact of multilateral trade reforms on economies.

IV. 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 phenomenon under investigation. In particular, the ability of a model to make realistic predictions is likely to be higher if the key results of the model 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 would not have any significant impact on the results.

In recent years, there has been a proliferation of models for global trade policy analysis. These models 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 of CGE trade models is the lack of validation of the models predictions. In other words there is no way to tell whether or not the predictions of CGE models 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 models 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 stylized facts about economies under investigation, and then comparing the models predictions on key macroeconomic variables to 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 to 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 and will ensure that CGE models capture certain facts about the trading system and increase the credibility of their results.

V. Risks, Challenges and Way Forward

Several African countries do not have 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 results of research carried out by international institutions and academics. When researchers present results that differ significantly both in terms of direction and magnitude, and there is no explanation as to why these discrepancies occur, policymakers 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 policymakers from developed countries African policymakers are often not in a position to evaluate these studies to determine how credible they are and how useful they are as bases for policy formulation. This can lead to one of two unattractive responses by African policymakers:

- The first is that 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;
- The second potential response is that policy makers may completely disregard results and recommendations from these studies in policy formulation and base their judgment on political realities and attitudes of the population 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 policymakers. Clearly, CGE models have an important role to play in economic policy formulation in Africa. When designed based on a sound theoretical framework, realistic assumptions and objective choice of parameters, they can provide policymakers with very useful insights into the functioning of their economies as well as form the basis for advice on what positions countries should adopt in multilateral trade negotiations. African countries should continue to pay attention to CGE models of trade policy but they should not base policy decisions solely on results of existing CGE models since they do not take into account important features of African 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 minimize the risks of policy errors.

There is a tendency for researchers to make recommendations to policymakers based on 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 scarce and limited resources to address

the enormous development challenges facing them, the cost of policy 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.

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, several African countries are not in the GTAP database and so most of the results from GTAP simulations refer to an aggregate group called "Rest of Sub-Saharan Africa." If the simulation results suggest positive welfare gains for the group, this is often interpreted as evidence that Sub-Saharan Africa would benefit from reform. However, given the wide diversity of countries in the group, one cannot rule out the possibility that several 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 that CGE researchers should take to increase the credibility of their model is that there should be 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 to have a more transparent way to disseminate 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 provide justifications for them. This type of transparency will ensure that results can be reproduced by other researchers and make comparisons and interpretation of results much easier.

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Table 1: Comparison of Results of CGE Models

Study/Model	Sectors	Reform scenario	Results
World Bank Anderson, Martin and van der Mensbrugghe (2005) • LINKAGE Model (Version 6) • Dynamic model • GTAP 6 database (preferences included) • Base year 2001	Agriculture Manufacturing	Full liberalization of merchandise trade over 2005 - 2010	• Global gains of $287 billion per year in 2015 • Gain to SSA is $4.8 billion (1.1% of income) Static Version • Global gain is $127.4 billion • Gain to SSA is $0.7 billion GTAP Elasticities and Land Fixed • Global gain is $77.8 billion • Loss to SSA is $0.1 billion
Hertel and Keeney (2006) • GTAP-AGR model (Static) • GTAP 6 database (preferences included) • Base year 2001	Agriculture Manufacturing Services	Full liberalization of merchandise trade	Merchandise Trade Liberalization • Global gain is $84.3 billion • SACU gains $1.1 billion • Loss to the group “Other SSA” of $1.03 billion (0.8 % of income) Agriculture liberalization • Global gains of $55 billion • SACU gains $529 million • The group “Other SSA” incurs $167 million loss

Study/Model	Sectors	Reform scenario	Results
CARNEGIE Polaski (2006) • GTAP Model (static) • GTAP 6 database (preferences included) • Base year 2001 • Incorporates unemployment in developing countries	Agriculture Manufacturing	Full liberalization and Partial reforms reflecting plausible Doha Round Scenarios	Full Liberalization • Global gain is $168.1 billion (0.5% of GDP) Doha Scenarios • Global gain of $59 billion • East Africa will lose about $0.1 billion and "Rest of SSA" will lose $0.2 billion.
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, Diaz-Bonilla, Robinson and Orden (2005) • Static CGE model • Variable employment • GTAP 5 database • (1997 base year)	Agriculture	Full liberalization of agricultural trade	• Gain to SSA is $1.2 billion • With productivity effects the gain is $1.7 billion • GDP expands in SSA by $1.7 billion and $2.1 billion with productivity effects

Study/Model	Sectors	Reform scenario	Results
UNECA / LEI Achterbosch, Ben Hammouda, Osakwe and van Tongeren (2004) • GTAP model (static and dynamic) • GTAP 5 database with tariffs adjusted for preferences and binding overhang • Variable employment	Agriculture Manufacturing	Full liberalization Moderate reform involving 50% reduction in all forms of protection	• Global gains of $84 billion (0.3% of income) • Gain to SSA is $704 million (0.3% of income) Moderate Reform • Global gains of $40 billion (0.1% of income) • Loss to SSA is $502 million (0.2% of income)
CEPII Bouet, Bureau, Decreux & Jean (2004) • MIRAGE model (static) • Imperfect competition in non-agricultural sector • Dual labour markets (efficiency wages) • MAcMap database (preferences included) • 2001 base year	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 of 0.08% of income • Loss to SSA of 0.03% of income.

Study/Model	Sectors	Reform scenario	Results
UNECA Ben Hammouda, Karingi, Oulmane, Lang and Sadni-Jallab (2005) • GTAP model (static) • GTAP 5 Database	Agriculture	Scenario 1: three bands for tariff reduction in developed countries. 40% reduction for tariffs less than 15%; 50% reduction for tariffs (15-90%); and 60% reduction for tariffs greater than 90%. Four bands for tariff reduction in developing countries. If tariff is in the range (0 < 20%) apply 25%. In the 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 in scenario 1 but with 5% of tariff lines in developed countries treated as Sensitive Products.	Scenario 1 • Gains to SSA is $943 million and for North Africa it is $2.4 billion • GDP expands by 0.47% in SSA and by 1.47% in North Africa Scenario 2 • Gains to SSA is $977 million and for North Africa it is $2.47 billion • GDP expands by 0.41% in SSA and by 1.51% in North Africa

Study/Model	Sectors	Reform scenario	Results
UNECA Sadni-Jallab , Ben Hammouda, Karingi, and Perez (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 are excluded. Also for 10% of the tariff lines in developing countries only 50% of the reduction specified by the Girard formula is applied. Scenario 2: Same as in scenario 1 but with B equal to 3.	Scenario 1 • Gains to SSA is $489 million and for North Africa it is $3.5 billion • GDP expands by 0.37% in SSA and by 1.7% in North Africa Scenario 2 • Gains to SSA is $337 million and for North Africa it is $2.79 billion • GDP expands by 0.21% in SSA and by 1.28% in North Africa

Table 2: Applied Tariff by EU25 to the GTAP group "Rest of Sub-Saharan Africa"

Sector	Code	MAcMAP (direct aggregation)	GTAP 6
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

Table 3: Applied Tariff by EU25 to the GTAP group "Rest of North Africa"

Sector	Code	MAcMAP (direct aggregation)	GTAP 6
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 4. Comparison of Tax Rates for 2001 (percentage rates)

Country	Consumption			Labor		Capital		Land	Natural Resources
	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
Great 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
United States	4.7	0.4	1.0	29.5	15.9	36.0	3.0	-34.5	3.0

Source: Gurgel, Metcalf and Reilly (2006)

Table 5: 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, Arndt and Hertel (2003).

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