Approaches to Measuring the Effects of Trade Agreements

CATPRN Commissioned Paper CP 2006-1

March 2006

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"Ask five economists and you'll get five different
answers – six if one went to Harvard."
Edgar R. Fiedler

Introduction

In measuring the effects of trade agreements, the problem for economists is usually not a lack of answers but rather an abundance of them. Economists have developed a variety of approaches to analyzing trade agreements that often give very different results. To an economist these discrepancies may be acceptable or even welcome because they can lead to insights as to why results differ from one modeling approach to another. However, among policy-makers and the general public, conflicting results can create confusion and undermine the credibility of applied trade policy analysis (Gohin and Moschini, 2004).

Conflicting estimates of the effects of trade agreements arise for multiple reasons. In some cases they reflect genuine uncertainty within the economics profession about the ways in which international trade may impact an economy and the magnitude of these impacts. The impacts of trade on productivity and technological change are good cases in point (Feenstra, 2004; Trefler, 2004). Another good case in point involves the values to assign to key parameters in economic models of trade, such as Armington elasticities of substitution, for which the knowledge base is weak (Hertel *et al.*, 2004). These sources of uncertainty are not easily glossed over and ultimately the only remedy is additional empirical research.

In other cases conflicting estimates reflect the use of multiple modeling approaches to answer the same question. Estimates often differ in sign—that is, who gains and who loses from a trade agreement—and significant differences in the magnitudes of estimated gains and losses are also common (Gohin and Moschini, 2004). For example, Tokarick (2003) compares estimated impacts of agricultural trade liberalization using a partial equilibrium (PE) model that he developed with those using the GTAP (Global Trade Analysis Project) computable general equilibrium (CGE) model (Hertel, 1997). Tokarick's PE model is similar in structure to many other PE models, while the GTAP model is the most widely used CGE model. His results from both models indicate agricultural trade liberalization increases social welfare in the EU, US, and Japan, but the magnitudes of the gains differ substantially between the two models. For the EU, social welfare gains are nearly three times greater with the CGE model than with the PE model. For Japan, they are over six times greater with the CGE model. On the other hand, social welfare gains for the US are only about half as large with the CGE model as with the PE model.

The thesis of this paper is that the use of multiple modeling approaches to answer the same question in applied trade policy analysis is almost always unwise. Instead, a single modeling approach should be chosen that is most appropriate for the problem at hand. This paper lays out criteria for choosing among modeling approaches. The paper then describes the key approaches in the economic literature to measuring the effects of trade agreements, with a focus on their relative strengths and weaknesses and on the situations for which each modeling approach is most appropriate.

This paper focuses on modeling approaches, not on specific models. Thus the paper discusses CGE modeling as one approach but not the GTAP model in particular. A specific model may or may not show a modeling approach in the best light. While the GTAP model is exemplary of the best in CGE modeling, there are many models that are poor representatives of their respective approaches. For instance, the SWOPSIM (Static World Policy Simulation) model, an

early partial equilibrium model developed by the US Department of Agriculture that was used in many agricultural trade policy analyses, is inconsistent with economic theory in several important respects and is weak in representing food processing and marketing activities (Peterson, Hertel and Stout, 1994). However, most of these limitations are not inherent to partial equilibrium modeling in general, and indeed there are more recent partial equilibrium models that have remedied most of SWOPSIM's deficiencies.

Choosing Among Modeling Approaches

In choosing among modeling approaches, one may ask "Which approach is the best?" This is fundamentally the wrong question. Instead, it is better to ask "Which approach is the best to answer the questions that I have?" No single model can fully capture all the possible impacts of a complex trade agreement. Analysts must weigh the desire for broad sectoral, product, policy, and country coverage with the need for detailed and accurate coverage of particular markets and policies (Westhoff *et al.*, 2004). An economic model is a rough approximation to the real world rather than an exact characterization, and must ultimately be judged on the degree to which it answers the questions it was designed to answer (Boland, 1989). As Anania (2001) argues, one reason why many models are less than satisfactory is that they were built for a specific purpose, such as medium-term market projections, and then used for another purpose without any modifications to their basic structure.

While it may seem obvious to recommend the approach most likely to answer the questions being asked, in practice other criteria often come into play. For example, the modeling approach that an analyst, or the analyst's organization, is most familiar with may be chosen even when it is not the most appropriate. This takes advantage of specialized skills within an organization but at the cost of using a model potentially ill-suited to the problem at hand. Along the same lines, the modeling approach in which an organization has invested the most resources may be used even when there are other, more appropriate approaches. This can occur when an organization has invested a large amount of money in a particular model and administrators are under pressure to demonstrate that the model is being used. Alternatively, a modeling approach may be chosen simply because it is intellectually fashionable at the moment. Economics, like every other human endeavour, is subject to fashion trends and fads (Sunstein, 2001). A good example from agricultural economics is the "translog dissertation" days of the 1970s and 1980s, when a large number of Ph.D. dissertations were written that estimated cost or profit functions and applied the results to one policy problem or another.

Time constraints within an organization can also affect the choice of modeling approach, and can force a trade-off between completeness and complexity in modeling. When an analyst is expected to have results ready within a few days, deadline pressure almost ensures that the approach taken will be a relatively simple variation on the one the analyst is most familiar with. When the deadline is several months away, an organization has more time to explore alternative approaches and if necessary acquire (through training, hiring, or outsourcing) the skills required to implement the most suitable approach.

The modeling approach need not be quantitative. Perhaps a qualitative analysis using economic theory would be sufficient, or perhaps the answer is intuitively obvious to experts in the area. In many cases, though, only a quantitative approach will suffice. A qualitative analysis might be able to say that an impact of a trade agreement is likely to be "large" rather than "small," but only a quantitative analysis can answer "how large?" or "how small?" questions. There are also many cases where economic theory cannot predict whether a variable increases or decreases. To

2

take a simple example, a production quota carries both benefits and costs to producers: the market price increases on the units of a good that are sold but fewer units are sold because of the quota. Theory tells us the conditions under which one effect dominates the other but cannot say which conditions hold in a particular market.

Past performance in successfully predicting the effects of trade agreements can provide insights as to which modeling approach is the most appropriate, but there are two issues in this regard. First, many (or most) of the models used to measure the effects of trade agreements are policy models rather than projection models. That is, they are designed to estimate what the world would have looked like had a trade agreement been implemented in the model's base period (e.g. 2005) rather than make projections about what the world will be like in the future with or without a trade agreement. Projections require assumptions about future changes in other relevant exogenous variables—depending on the model, these could be variables such as population, per capita income, crop/livestock yields, exchange rates, and policies other than the trade agreement. Second, even if we restrict ourselves to projection models, projections could be wrong not because of a failure to adequately represent the effects of a trade agreement but rather because of incorrect assumptions about future changes in exogenous variables or how changes in those exogenous variables will impact the economy.

Key Modeling Approaches

The key approaches to measuring the effects of trade agreements can be grouped into two broad categories: econometric models and simulation models. In both approaches, a model consists of a system of mathematical equations that depict selected relationships in an economy or group of economies. Each equation has parameters that characterize how one economic variable is related to another within the model. With both approaches, a model can vary according to geographic scale (from a single farm field to the entire world), units of analysis (from individual firms to countries and global regions), temporal scale (daily to periods of several years), and product/sector scope (specific crop or livestock varieties to broad sectoral groupings such as agriculture as a whole).

Econometric and simulation models differ in how values are assigned to the parameters (McKitrick, 1998). In econometric models the parameters are estimated using statistical techniques. In simulation models parameter values are typically drawn from a variety of sources, including prior econometric studies, other simulation models, and analysts' intuition and judgment. In essence, econometric models combine parameter estimation and model validation in the same analysis, while simulation models break these two steps apart. Parameter values in simulation models are usually assigned such that, given base-period policies and market conditions, the model exactly reproduces the model's base period data. In both econometric and simulation models, economic theory is typically used to help assign parameter values (e.g. consumer demand equations must be homogenous of degree zero in prices and income).

In between these two broad categories are hybrid approaches that combine features of both econometric and simulation models. There are simulation models in which some parameters, such as Armington elasticities of substitution, are econometrically estimated while values of other parameters are obtained in the usual ways (e.g. Hertel *et al.*, 2004). There are also econometric models in which some estimated parameters are adjusted based on analysts' intuition and judgment. For example, an analyst may believe that structural change in a market has caused a parameter to be larger or smaller than it was during the time period for which it was econometrically estimated.

Statistical estimation of parameter values has both benefits and drawbacks. It has the advantage that parameter estimates come with confidence intervals, so that the modeller can see their precision. Simulation modellers taking econometric estimates drawn from the literature typically ignore the precision of these estimates (Hertel *et al.*, 2004; McKitrick, 1998). This can lead to false confidence in the reliability of model results if the results are highly sensitive to the values of parameters whose estimates are imprecise. Basing parameters values on a meta-analysis of prior econometric studies can alleviate this problem by showing the variability of estimates in the literature and providing a range of parameter values that can be tried (Abler, 2001). However, a meta-analysis is only possible if there a reasonably large number (say 20 or more) of estimates of a particular parameter in the literature. In many cases there are few or no existing estimates of a parameter.

Parameter estimation takes advantage of improvements in time series econometric techniques during the past two decades. Many of the parameters of popular simulation models can be traced back one way or another to time-series studies from the 1960s and 1970s. These parameters were estimated using econometric techniques that we now know are often fundamentally wrong and prone to serious estimation biases. Estimation also ensures that parameters are perfectly matched with the model, whereas using parameter estimates from prior studies can lead to modeling mismatches. Estimates from prior studies typically employ different levels of aggregation, and exploit different sources of price variation, than what policy modellers have in mind (Hertel *et al.*, 2004). On the other hand, parameter estimation "locks in" a particular product/sectoring scheme, making it necessary to re-estimate parameters if products or sectors are redefined (Francois and Reinert, 1997).

Parameter estimation is intensive in research resources that could be used elsewhere (Francois and Reinert, 1997). One must balance the potential benefits of parameter estimation against any modeling or analyses that would be foregone. On occasion estimation can also produce econometric results that make no sense (e.g. a high income elasticity of demand for a basic grain like wheat in a developed country such as the US). Policy analysts who value their credibility would never use a nonsensical result such as this, but would probably move to a hybrid approach in which some parameters were adjusted to more intuitively plausible values.

Beyond the issue of parameter estimation, the chief advantage of econometric modeling is that it involves real data and, assuming a study is methodologically sound, provides real results. A well-done study indicates what actually happened in response to some trade agreement, and can provide a learning opportunity for the design and negotiation of future trade agreements. With a few exceptions (Abrego and Whalley, 2005), simulation models of trade agreements are forward-looking "what if" exercises that do not seek to explain economic history.

A drawback of econometric modeling is that the results are specific to one country or one group of countries. For example, studies of CUSTA may be of some relevance to other bilateral trade agreements involving two developed countries, but their relevance to a trade agreement between a developed and developing country, or between two developing countries, is doubtful because of the much different nature of bilateral trade in those cases. Along the same lines, the results are specific to a trade agreement already in place, and they may not apply to a prospective trade agreement that has significantly different terms. This problem is exacerbated by the fact that most econometric studies utilize a pre/post methodology that assesses the effects of an entire trade agreement rather than breaking effects down by the individual components of the agreement. This leaves a policy analyst who is examining a particular component of a prospective agreement without econometric evidence on the impacts of similar components in previous agreements.

Another drawback of econometric modeling is that results are historical in nature and may no longer be relevant. By their nature, trade agreements often require significant changes in policies that fundamentally change the decisions faced by economic agents, and may lead to a new economic environment where historical relationships no longer hold. The well-known Lucas critique states that econometric models estimated under a specific set of government policies cannot be used to analyze a different set of policies because the parameters of an estimated model embody the policies under which the data were generated. As Just (2001), quoting an unnamed economic historian, puts it, "Economic history is all about structural change and econometrics is all about avoiding it" (p. 1136). Even when a trade agreement does not change the basic structure of agent decision making, it can cause economic variables to move far outside of the range of historical data. Econometric models are fundamentally backward-looking, and the domain of applicability of an econometric model is limited to the historical range of the data used to estimate the model (Devarajan and Robinson, 2005).

Table 1 summarizes the merits of econometric versus simulation models in terms of parameter values and model results on the criteria discussed here. Putting it all together, econometric models are the most suitable approach when the interest is on the historical impacts of a trade agreement already in place, impacts that may be helpful in the design and negotiation of future trade agreements. Econometric models are also the most suitable approach when the knowledge base upon which to draw parameter values for a simulation model is weak. Parameters capturing the impacts of trade on productivity and technological change are good examples. Simulation models are the most suitable approach when the interest is on a prospective trade agreement with significantly different terms from existing trade agreements, or trade agreements that cover different pairs or groups of countries than those in existing agreements. Simulation models are also the most suitable approach when the interest is on a prospective agreement that is likely to cause structural change in global or domestic markets, or one that is likely to lead to economic conditions outside of the range of historical data.

Table 1. Econometric versus Simulation Models

Criterion	Econometric Models	Simulation Models
Parameter Values		
Can determine precision of parameter estimates	✓	
Parameter values derived using modern econometric techniques	✓	
Parameter values perfectly matched with model	✓	
Avoids product/sectoring scheme "lock in"		✓
Economizes on research resources required to obtain parameter values		✓
Role for analyst judgment in avoiding nonsensical parameter values		✓
Model Results		
Real data, real results; no hypothetical exercises	✓	
Results can be generalized to different countries and regions		✓
Can analyze prospective trade agreement significantly different from existing agreements		✓

Table 1. Econometric versus Simulation Models

Criterion	Econometric Models	Simulation Models
Can handle structural change that alters historical relationships		✓
Can handle economic conditions outside range of historical data		✓

Econometric Models

Econometric models for measuring the effects of trade agreements fall into two general classes: models designed to predict trade flows between countries, and models designed to predict the economic impacts of trade. Economic impacts of interest in the literature include employment and wages, productivity, competition, and firm survival and exit.

Among models designed to predict trade flows between countries, by far the most popular modeling approach is the gravity model. The gravity model predicts that bilateral trade flows are proportional to the product of the incomes of two trading partners and inversely related to the distance between them. "Distance" in recent versions of the gravity model refers not only to physical distance but also to distance created by trade barriers; the presence or absence of colonial ties, customs unions, and common borders; the quality of political and economic institutions in the two trading partners (political stability, political and economic freedoms, control of corruption, enforceability of contracts, application of the rule of law); and distance created by differences in languages, ethnicities or religions (de Groot, Rietveld and Subramanian, 2004; Egger, 2002).

The gravity equation is one of the great success stories in economics, with many studies successfully accounting for variation in the volume of trade across country pairs and over time (Sheldon, 2006). Much of the recent literature on the gravity model has focused on strengthening its theoretical foundations, and on whether it can be used to distinguish among alternative theories of international trade (Anderson and van Wincoop, 2003; Evenett and Keller, 2002; Feenstra, Markusen and Rose, 2001). Recent empirical applications of the gravity model to trade agreements and their effects on agricultural trade include Nouve and Staatz (2003), who estimated the impacts of the Africa Growth and Opportunity Act on African exports to the US, and Skripnitchenko, Beladi and Koo (2004), who attempted to estimate the agricultural trade-creating and trade-diverting effects of several preferential trading arrangements (including NAFTA, the European Union, the Andean Community, and ASEAN).

There is a very large econometric literature on the economic consequences of international trade. Recent studies have looked at employment (Beaulieu, 2000; Levinsohn, 1999; Trefler, 2004), wages (Beaulieu, 2000; Trefler, 2004), productivity and technological change (Feenstra, 2004; Pavcnik, 2002; Krishna and Mitra, 1998; Trefler, 2004), competition (Krishna and Mitra, 1998), and firm survival and exit (Baggs, 2005; Pavcnik, 2002). CUSTA has drawn the attention of several researchers because of the relatively rich economic data available for Canada and the United States. These studies are not typically designed to test any particular economic theory. Instead they are designed to estimate relationships that may be important in analyzing the effects of trade agreements or in formulating theories of international trade, particularly longer-term effects on productivity and technological change. These effects are missing from most simulation models of trade impacts.

Simulation Models

Simulation models for measuring the effects of trade agreements fall into two general classes, partial equilibrium (PE) models and computable general equilibrium (CGE) models. CGE models are also referred to in some of the literature as applied general equilibrium (AGE) models. PE models cover a limited set of goods and services within an economy or group of economies. They consider the food and agricultural sector as a closed system that does not have significant effects on the rest of the economy, although the rest of the economy can still affect food and agriculture. CGE models cover all goods and services simultaneously within an economy or group of economies. They consider the food and agricultural sector as an open system that can potentially have significant effects on the rest of the economy. A large number of PE and CGE models have been used to analyze agricultural and trade policies. A good review of many of these models can be found in van Tongeren, van Meijl and Surry (2001). Other reviews in the context of the EU's Common Agricultural Policy (CAP) can be found in Conforti (2001) and De Muro and Salvatici (2001).

For reasons discussed above, it is pointless to argue whether PE or CGE is the superior modeling approach. Instead, the literature on PE and CGE modeling indicates that each approach has its benefits and drawbacks, making PE modeling the best choice in some circumstances and CGE modeling the best choice in others.

Economy-Wide Linkages. Capturing economy-wide linkages among producers and consumers is where CGE models shine. Changes in the agricultural sector could potentially have significant effects on national income and in turn demands for goods and services, including food. This is most likely to occur in developing countries where agriculture is a large percentage of national income. Changes in the agricultural sector could also have a significant impact on a country's real exchange rate, and in turn on prices of all goods and services. Once again this effect is most likely to be important in countries where agriculture is a large proportion of the economy. The agricultural sector could have significant impacts on wage rates, at least for some types of labour, in an economy where agriculture accounts for a large percentage of the labour force. By construction, PE models rule out linkages between agriculture and the rest of the economy. If there are reasons to believe that economy-wide linkages are likely to be important to the problem at hand, then CGE modeling is the preferred approach.

Conceptual Consistency. CGE models force conceptual consistency on a problem. They acknowledge a fixed resource base (land, labour, capital), measure the opportunity cost of factor movements between sectors as a result of a policy shock, and include explicit budget constraints for all households and for the government. PE models lack budget constraints that fully account for the opportunity cost of resources, and there is no linkage between factor income and expenditure (Conforti, 2001). Most PE models of the agricultural sector lack factor markets, instead expressing output supply (or acreage and yields for crops in some models) as a function of output prices only. An exception in this regard is the OECD's policy evaluation matrix (PEM) model, which has markets for land, farmer-owned inputs (labour and capital), and purchased inputs (Dewbre, Antón and Thompson, 2001).

Consistency with Theory. CGE models are designed from the ground up to be consistent with economic theory. The equations of a CGE model are derived from the assumption of optimizing behaviour on the part of producers and consumers subject to budget and resource constraints. PE models, on the other hand, generally contain at least some inconsistencies with theory on both the supply and demand sides. For example, it is well-known that a system of consumer demand equations should be derivable from an underlying utility function, and as such

should satisfy symmetry, homogeneity, and adding up requirements. Most PE models ignore one or more of these requirements (Peterson, Hertel and Stout, 1994). Demand elasticities in PE models with constant-elasticity demand equations can be calibrated such that these requirements are satisfied in the model's base period, but in this case price movements away from base-period values will cause the requirements to be violated.

A CGE model's consistency with economic theory, combined with its conceptual consistency and ability to capture economy-wide linkages, makes it generally the best approach for social welfare calculations. A PE model can do a good job of estimating changes in producer surplus, consumer surplus, and net government expenditures within the agricultural sector but no more. A CGE model can provide theoretically consistent welfare calculations accounting not only for distortions within agriculture but also for how changes in the agricultural sector may diminish or augment distortions elsewhere in the economy (Gohin and Moschini, 2004).

Complexity. CGE models are highly intensive in data and parameters. Underlying each CGE model is a social accounting matrix (SAM) that records all transactions in an economy between firms, households, the government, and foreign entities. A SAM is constructed in an internally consistent manner such that supply equals demand for all goods and factors, tax payments equals tax receipts, there are no excess profits in production, household expenditures equal the value of factor income plus transfers payments, and government tax revenues equal transfer payments. The typical CGE model also requires that values be assigned to a large number of parameters, and for reasons discussed above this can be a difficult task. In many circumstances it may be difficult to justify devoting scarce resources to a complex CGE model when it may only yield marginal gains over basic insights drawn from a PE model (Francois and Hall, 1997).

Feasibility of Disaggregation. Generally, disaggregation of sectors into relatively fine categories is more feasible in a PE model than in a CGE model. Many countries have highly detailed trade policies applying to specific products that are a small proportion of the entire economy. Within a CGE model, each additional sector requires an additional row and column in the SAM showing that sector's receipts from, and payments to, all other sectors in the economy. For finely detailed sectors (e.g. different types of wheat), the necessary data to construct the SAM are unlikely to be available, making a PE model the only realistic approach (Francois and Reinert, 1997).

Finely detailed PE models excel at answering questions about "Ps and Qs"—changes in prices and quantities supplied/demanded for specific products that a CGE model could never answer. However, unlike a CGE model, a finely detailed PE model carries the risk of missing the forest for the trees. For example, a positive welfare effect in a detailed agricultural sector from a PE model is not necessarily more credible than a negative welfare effect for a more broadly-defined agricultural sector in a CGE model (that encompasses the detailed sectors from the PE model) simply because it is derived from an approach that yields finely detailed results. Detail is not a substitute for correct results.

Policy Representation. When incorporating a government policy into a simulation model, three properties are important: accuracy (the policy is represented in the model in a manner reasonably akin to how it actually operates); tractability (no unwieldy equations making it hard for the model to solve); and consistency with economic theory. Unless the policy is fairly simple, these three goals will come into conflict. In some cases the conflicts are minimal; in other cases they are substantial and choices among goals must be made.

CGE models by their nature require consistency with theory. PE models, on the other hand, can sacrifice some theoretical purity when needed to preserve the properties of accuracy and tractability, especially accuracy. The structure of PE models is more flexible than CGE models, making it easier to incorporate the complicated agricultural policy mechanisms that we observe in practice (Rude and Meilke, 2004). CGE models often represent agricultural and trade policies in a very simple manner through the use of "price wedges" that create a gap between domestic and world prices, or a gap between producer and consumer prices. Price wedges are consistent with theory and very tractable, but they may be a woefully inaccurate representation of how a policy actually operates (Anania, 2001).

Timeliness. CGE models often lag on policy and market information (Westhoff *et al.*, 2004). For example, the GTAP model's most recent database (version 6.0) is for 2001 but was released in 2005. For many issues using a four- or five-year old database is perfectly acceptable. However, such a time lag is too long for many of the issues that PE modellers are called upon to address, such as short- and medium-term market projections, where timely data are crucial for accuracy and credibility with clients.

Length of Run. Most CGE models make assumptions that are long-run in nature, such as perfect factor mobility (capital, labour, materials) among sectors, and relatively high substitutability among inputs into production. As a result, the elasticities of output supply implied by most CGE models tend to be substantially greater than the supply elasticities used in most PE models. PE models typically take a short- to medium-run perspective in assigning values to supply elasticities and other parameters. Thus, the length of run of interest to the policy analyst can play a role in the choice of modeling approach.

Past Performance. Simulation modellers generally do not look back to see how accurate their projections of the impacts of trade agreements were, at least not in published papers. However, available publications suggest that both CGE and PE models have room for improvement on this criterion. Kehoe (2005) uses data on actual changes in trade flows among Canada, the US and Mexico between 1988 and 1999 to evaluate the performance of three prominent CGE models that were used in the early 1990s to estimate the impacts of NAFTA. He finds that these models dramatically underestimated the impact of NAFTA on North American trade. Trade relative to GDP increased by over 1,000% in many sectors between 1988 and 1999, while the CGE models predicted changes in trade relative to GDP of less than 50% in most sectors.

Kehoe (2005) argues that the Armington approach to substitution in consumption between domestic and imported goods in these CGE models had the effect of locking in pre-existing trade patterns and prevented the models from generating large changes in trade in sectors where little or no trade occurred before NAFTA. In fact, all models using an Armington assumption have a "stuck on zero trade" problem. If a country's imports of a product from another country are zero initially they will always be zero, regardless of changes in policy or market conditions. If imports are non-zero but small they will remain small even if there are large changes in prices. The Armington assumption is common to CGE models and many PE models, but it is not an inherent feature of either modeling approach. It may also be noted that very large numbers tend to be viewed with suspicion, and any model in the early 1990s projecting increases in trade of over 1,000% in response to NAFTA probably would not have been seen as credible.

Carpentier (2001) evaluated the performance of two *ex ante* PE models used to project the effects of NAFTA on North American agricultural trade against *ex post* assessments of the impacts of NAFTA. The *ex post* assessments attempted to isolate the effects of NAFTA from other

variables influencing agricultural trade. In general, the *ex ante* models reviewed by Carpentier (2001) came closer to hitting the mark than the CGE models reviewed by Kehoe (2005). However, the PE models still tended to under-predict increases in agricultural trade, particularly in US exports of grains and oilseeds to Mexico. Carpentier (2001) does not discuss what features of these PE models might have led them to underestimate trade increases.

Table 2 summarizes the merits of CGE versus PE models in terms of the criteria discussed here. CGE modeling is the most appropriate for countries in which agriculture is a large proportion of the economy or countries in which agriculture accounts for a large percentage of the labour force. CGE modeling is also the most appropriate if the analyst is interested in social welfare calculations. On the other hand, PE modeling is the most appropriate if the focus is on finely detailed sectors (e.g. different types of wheat) or on complicated agricultural policy mechanisms that are difficult to represent accurately and tractably without sacrificing some consistency with economic theory. Because CGE models typically lag on policy and market information, PE modeling is also the most appropriate for issues where timeliness is crucial. CGE models tend to generate results that are long-run in nature, while most PE models are constructed with a short- to medium-run perspective.

Table 2. Computable General Equilibrium (CGE) versus Partial Equilibrium (PE) Models

Criterion	CGE Models	PE Models
Capturing economy-wide linkages among producers and consumers	✓	
Conceptual consistency that recognizes resource and budget constraints	✓	
Consistency with economic theory	✓	
Avoiding complexity in data and parameters		✓
Ability to disaggregate sectors into relatively fine categories		✓
Ability to represent complicated policy mechanisms observed in practice		✓
Use of timely data		✓
Capturing short- and medium-run effects		✓
Capturing long-run effects	✓	
Past performance in projecting impacts of trade agreements	(neither has an edge)	

Conclusions

Clarity and credibility in applied trade policy analysis suggest that a single modeling approach should be chosen that is most appropriate for the problem at hand. In choosing a modeling approach the desire for broad sectoral, product, policy, and country coverage must be balanced against the need for detailed and accurate coverage of particular markets and policies.

The key approaches to measuring the effects of trade agreements can be grouped into two broad categories: econometric models and simulation models. The two categories differ in regard to how values are assigned to model parameters—in econometric models the parameters are

estimated statistically while in simulation models they are typically drawn from prior econometric studies, other simulation models, and analysts' intuition and judgment. Within the econometric approach, there are models designed to predict trade flows between countries (most of which are applications of the gravity model), and models designed to predict the economic impacts of trade. Within the simulation approach, there are partial equilibrium (PE) models and computable general equilibrium (CGE) models.

Econometric models are the most suitable approach when the interest is on the historical impacts of a trade agreement already in place, impacts that may be helpful in the design and negotiation of future trade agreements. Econometric models are also the most suitable approach when the knowledge base upon which to draw parameter values for a simulation model is weak. Parameters capturing the impacts of trade on productivity and technological change are good examples. Simulation models are the most suitable approach when the interest is on a prospective trade agreement with significantly different terms from existing trade agreements, or trade agreements that cover different pairs or groups of countries than those in existing agreements. Simulation models are also the most suitable approach when the interest is on a prospective agreement that is likely to cause structural change in global or domestic markets, or one that is likely to lead to economic conditions outside of the range of historical data.

Between PE and CGE modeling, CGE modeling is the most appropriate for countries in which agriculture is a large proportion of the economy or countries in which agriculture accounts for a large percentage of the labour force. CGE modeling is also the most appropriate if the analyst is interested in social welfare calculations. On the other hand, PE modeling is the most appropriate if the focus is on finely detailed sectors (e.g. different types of wheat) or on complicated agricultural policy mechanisms that are difficult to represent accurately and tractably without sacrificing some consistency with economic theory. Because CGE models typically lag on policy and market information, PE modeling is also the most appropriate for issues where timeliness is crucial. CGE models tend to generate results that are long-run in nature, while most PE models are constructed with a short- to medium-run perspective.

When measuring the effects of trade agreements the problem for economists is usually not a lack of answers but rather an abundance of them. The guidelines in this paper are intended to hopefully reduce the cacophony and produce more a consistent and convincing story on the effects of trade agreements on the food and agricultural sector.

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