Modeling Agricultural Trade Liberalization

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In the years leading up to the launch of the Uruguay Round of trade negotiations under the General Agreement on Tariffs and Trade (GATT) in 1986, it became apparent that the liberalization of agricultural trade was finally a real possibility, after being largely neglected in previous negotiations. There was considerable interest in trying to evaluate the implications of a reduction in barriers to agricultural trade, in particular, to estimate the benefits and costs of freer trade, and to inform those involved in the negotiations. Academic economists, and some international organizations such as the Food and Agriculture Organization (FAO) and the Organization for Economic Cooperation and Development, constructed various types of economic models to try to determine the likely impact of freer trade. Agencies in national administrations, such as the Economic Research Service (ERS) of the U.S. Department of Agriculture were also involved in these efforts.

The launch of a new set of negotiations on agriculture in 2000 under the World Trade Organization (WTO) has again renewed interest in the empirical analysis of agricultural trade liberalization. In this paper, I set out some of the basics of model construction and use. This paper focuses primarily on some of the key considerations in the choice of model type. It also examines briefly the menu of available models, and makes some observations on the uses to which models are put and the usefulness of the information that they generate.

What is an economic model?

Stated simply, an economic model is a mathematical representation of the functioning of an economic system. International trade models try to capture how domestic production and consumption respond to changes in domestic prices and the consequent impact of variations in these quantities on the volume of trade and on international prices. Most economic models rest on the assumption that it is possible to reach an equilibrium in which supply and demand balance (production equals consumption plus changes in stocks), and that prices around the world will reflect this equilibrium. This does not mean that prices will be the same in every country. Most models attempt to capture the causes of prices, particularly through government policies. Various forms of government intervention can cause producer and consumer prices to be higher or lower than would otherwise be the case.

A model permits us to analyze the impact of changes in the forces that shape trade. Some of the most important forces are technological change and population growth. Population growth typically increases the demand for agricultural products; technological change and improved management allow us to increase production from the relatively fixed amount of land available for agricultural use. Most models also allow us to examine the effects of changes in government policies, such as domestic subsidies and taxes and the counterparts applied at the border. In most of the models that examine agricultural trade,

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this is the primary focus. This is because government intervention in agriculture is pervasive and complex, particularly in developed industrial countries, and has a far greater impact on trade than in most other sectors[2].

Real world economic systems are extremely complex. There are many forces, which shape production, consumption and trade. There are differences among commodities, products and countries, and between the behavior of economic agents, firms and consumers. Models cannot take into account all the differences that exist, partly because this would make them extremely large and cumbersome to manipulate, although this is less of a consideration in an era in which computer processing power doubles on average every two years or less. The real constraint is that we often do not have access to data that would allow us to reflect differences and complexities, and our ability to explain the complex behavior of economic agents is limited.

Considerations in choosing the type of model

There are two approaches to model choice. These can be termed the "supply-side" approach and the "demand-side" approach. The supply-side approach is one in which the models that are made available are determined by what the constructors of models (the modelers) choose to produce. The structure of such models and the outputs that they generate will be driven by the interests of the builder and reflect her/his views of what constitutes a worthwhile representation of an economic system. The resulting model may be theoretically and mathematically elegant, but may only be understandable to the cadre of model builders. It may generate information that is primarily of interest to other model builders. However, it may only coincidentally provide information that is of interest to policymakers and to the general public. The demand-side approach is one in which consumers of the information to be generated by a model specify what they want to know. The model builder then tries to construct the model that will generate the required information, and to make the results as understandable as possible.

In reality, a successful model – i.e., one that produces results that are useful to more than just model builders will have elements of both processes. Model builders will inevitably try to steer potential users of their information towards what they feel confident to produce and to explain; thus permitting them to focus on type of model with which they feel comfortable. However, in doing so they will be sufficiently sensitive to the needs of the users of the information to adapt the model to meet as closely as possible the users' needs.

Choice of indicators

Among the range of indicators that can be provided by trade models are:

1. Net trade volumes and domestic and world prices – in this case we abstract from any differences among domestic products or between domestic and imported products to focus in changes in net trade volumes (imports-exports). We also assume that representative prices can be identified, both domestically and internationally. Typically we would choose a price from a major domestic market

[2] There are exceptions. Textiles and steel are two industrial sectors, which are targets for substantial government intervention in many countries.

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for the domestically product, and the export or import price in a major trading country for the traded product. These indicators are quite useful when countries use policies that apply to all exports or imports of a particular product, and do not differentiate among import suppliers or export destinations.

2. Country-to-country trade flows and prices – if we are unwilling to assume that domestic and imported products are broadly similar, then we can identify products by place of origin. This allows us to determine actual bilateral trade flows and the set of prices at which these take place. If there are government policies that focus on particular bilateral flows (e.g., preferential tariffs or market access for certain countries), this type of approach will be needed to capture their effects.
3. Economic welfare – we may wish to go beyond quantities and prices to determine the economic costs or benefits of trade for the country as a whole, or for groups within the country. The use of measures based upon economic surplus (producer, consumer and rents to other participants) provides a convenient way to calculate these costs and benefits and to aggregate them. It can be a challenge in complex models to calculate economic surplus, and to convey the meaning of such calculations to those who are not trained in economics.
4. Factor use and returns, and consumer expenditures – these indicators can be more understandable to the non-specialist, although they do not have the same economic content and do not lend themselves to the production of overall summary measures of gains or loss. Nevertheless, they can be a useful addition to surplus measures for models that are able to generate this information.
5. National income and trade balances – these indicators can only be generated by models that have a complete representation of the economy and trade. For such models, this type of information is very useful. However, given the small size of the agricultural sector in many industrial countries, changes in agricultural trade policies may not generate large changes in national income. Such information is more useful to countries with larger agricultural sectors, or when a general liberalization of trade policies (agricultural and other) is being considered.

Level of aggregation

The level of aggregation is an important choice in model construction. In most trade models, the issues revolve around commodity and geographical aggregates.

Commodity coverage can range from the relatively disaggregated, for example, skim milk powder, to the highly aggregated, for example, livestock products. With higher levels of aggregation it is simpler to reflect the economic forces that affect trade, but more difficult to represent policies in a meaningful way. It can be fairly complex to build a model that captures the interactions between the production, consumption and trade in butter, milk powder, liquid milk, cheese and other dairy products, for example. Policymakers are often interested in fairly disaggregated information. The constituencies with which they deal tend to be commodity specific, e.g. representing beef or dairy producers, rather than livestock producers as a whole.

The geographic units in trade models are most often countries, but can involve further disaggregation. Thus one might have a European dairy model that identifies major dairy

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regions at member state level rather than industries in member states or a component that represents the EU dairy industry as a whole. If the consumers of the information were in the United States, an EU aggregate would probably be sufficient. The number of geographic units in a model is also an issue. An EU-focused model might simply have two entities – the EU and an aggregate for the rest of the world. Alternatively, it might have several countries or regions – for example, major trading partners or important countries in trade negotiations.

Higher levels of commodity or geographical disaggregation increase data and other information needs. For this reason, the choice of the level of aggregation is an important one for any model builder.

Periodicity

Most trade models are annual models. They can be static, relating to a single year or an average of years in the past or the future, or dynamic, tracing out a time path into the future. One advantage of static models is that they are relatively easy to solve mathematically. It is possible to build some quite complicated structures into a static model (e.g., bilateral trade flows) and to manipulate models with a high level of commodity and country disaggregation. However, the interpretation of results from static models can be challenging for policymakers and the general public. Typically, such models contain medium term elasticities and use an historical reference period. In this case, we would present the results as: "this is what the outcome would have been in year X if we had made the changes several years previously, and all the adjustments had worked themselves through the system." The meaning of such results can be difficult to convey to the general public.

Analyses of the future can be made on the basis of forecasts or projections. Forecasting models require a lot more information in order to devise a time path that replicates what has happened in recent years, and provide a reasonable set of values for the future. Given the amount of information required, few trade models purport to provide forecasts; the usual approach is to present projections. This requires information on a key set of underlying drivers in the economic systems, such as the rate of technical change. It is possible to use non-dynamic models to derive projections, i.e., to provide a series of static snapshots of the future, but the richest information is derived from dynamic models that can trace changes from year to year. Dynamic models reflect the lags in adjustment that are often present in agriculture. With such lags, changes in policies may have differing effects, depending on how they are phased in. Policymakers, in particular, are interested in knowing how a change in policy may affect domestic markets over a series of years. As indicated, most trade models make annual projections but shorter periodicities are possible (quarterly or monthly). However, these are relatively rare.

Treatment of other sectors

Some trade models focus entirely on the agricultural sector. These are partial equilibrium models and treat changes in consumer income and non-agricultural prices as exogenous. Other models include a complete treatment of the economy with the interactions among sectors. In such models, all prices and national income are endogenous.

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Policy detail

A choice has to be made on how much policy detail to include in models. During the Uruguay Round negotiations most models tended to employ a relatively simple treatment of policies. Wedges between domestic and international prices were used to summarize the impact of policies. Market price support and associated trade restrictions (tariff and non-tariff barriers) were represented as a wedge affecting both domestic producer and consumer prices. Output subsidies were represented as a wedge that affected only producer prices.

The agreement on agriculture (AoA) that resulted from the Uruguay Round has created a far greater challenge for model builders. The Agreement created a complex system of tariffs, and introduced limitations on export subsidies and domestic support. In addition, domestic agricultural policies have been changing dramatically in many countries, with a tendency away from traditional forms of support to those that qualify as exempt under "green box" (minimally production and trade distorting) criteria. It is very difficult to examine changes in current domestic agricultural and trade policies by using simple price wedges. Models are moving towards the inclusion of specific policy instruments, such as tariffs, tariff rate quotas, export subsidies and domestic support instruments. Many countries are interested in the interaction between potential changes in trade measures and their domestic policies. This adds further impetus to the inclusion of specific instruments in models.

While the treatment of tariffs and export subsidies can pose some technical challenges, the incorporation of domestic policy instruments is extremely problematic. This is because it is often difficult to determine the impact of these instruments on production. It used to be possible to assume that a dollar's worth of direct support to producers had the same impact on production, regardless of the form in which the payment was made. It is extremely difficult to make the same assumption today.

Technical considerations

There are a number of technical considerations that affect the choice of model and its structure. The first of these is theoretical. Economic theory suggests a number of restrictions on the economic relationships that are included in models. On the demand side, for example, a theoretically consistent set of demand equations should satisfy homogeneity and symmetry. In some models, particularly partial equilibrium models, little attention is paid to whether demand equations satisfy these conditions. However, there are attempts to make sure that theoretical requirements apply at least at the starting values for model simulations, even if it is not possible to ensure that they apply across all values. In constructing models, incomplete information is frequently available on key parameters. Few models are estimated econometrically, although some of the parameters may be gleaned from econometric studies. Judgment, in addition to theoretical restrictions, is used as a means of determining reasonable values for parameters.

Most models assume that agricultural markets are broadly competitive (with the exception of the effects of government policies on price formation and trade). There have

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been few attempts to incorporate imperfect competition into models that are used to evaluate changes in policies, because of the complexity of doing so.

In model construction, a further technical issue is whether the model is to be used to examine large or small changes in policy parameters. Models that will work well with small changes may not work well with large changes. The incorporation of substantial domestic policy detail helps to provide reasonable predictions of what might happen if changes in trade policies are introduced, providing that such changes do not in themselves make the domestic policies unworkable. When changes are of such a magnitude that significant structural adjustment in policies is required, the task of modifying the model to reflect what might happen becomes a major task.

Finally, computational complexity is a technical issue. The major expansion in computing power means that solving large and complex models is becoming increasingly easy. Solution problems are more likely to be created by inconsistencies created by changes in policies, than by the inability of modern computers to handle large and relatively complex sets of equations.

Model choice – the menu

As indicated above, two broad classes of models exist for the analysis of changes in domestic and international policies – partial and general equilibrium models. Partial equilibrium models can be of the net trade type, determine gross exports and imports separately, or individual country-to-country trade flows. The level of complexity and data requirements increase as one progresses through these categories. General equilibrium models typically explain gross imports and exports, although not necessarily bilateral trade flows.

General equilibrium models introduce considerable complexity, but can add substantial richness to the analysis of changes in agricultural policies, particularly where these changes have a significant impact on other sectors, or where changes in agricultural policies are part of more general policy changes affecting multiple sectors. General equilibrium analyses are particularly useful for examining the impact of changes in agricultural policies in developing economies, because agriculture often accounts for a significant share of national income and employment in these countries.

In general, there is a trade-off in terms of the level of aggregation of commodities and policies between partial and general equilibrium models. Partial equilibrium models tend to permit greater disaggregation of commodities and policies than general equilibrium models. However, general equilibrium models capture the whole economy effects of policy change, and its impact on national income.

Model use and usefulness

In constructing and using a model to analyze changes in policies, it is important to bear in mind that a model is a simplification of reality, and, as such, has its limitations. Policymakers or the public at large may less readily accept concepts that modelers take

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for granted – such as competitive markets, homogenous products, and the existence of "world" prices.

It is also important to note that any given model cannot be expected to "do it all" – to provide answers to just about anything anyone could conceivably ask. A lot of time and effort has been wasted in the past on building large models that could answer a large variety of questions. Their use and usefulness has been disappointing. There has been a tendency on the part of model builders involved in such efforts to complicate unnecessarily their models, and to lose sight of priorities in what the model might be expected to generate. Most of the relatively successful models, in terms of their impact on public debate, have focused on providing insights into a particular set of questions, and in doing this well.

The most important contributors to a successful model are the quality of the basic assumptions and focus on the desired output. It is particularly important that models with a policy focus have a plausible specification of those policies and their effects. The representation of domestic and trade policies must be plausible and as accurate as possible. If the potential users of model output are not comfortable with the way that policies are treated in a model, they are unlikely to accept the output of the model as having much credibility.

Conclusions

The launch of a new set of negotiations on agricultural trade policies in the World Trade Organization (WTO) has stimulated renewed interest in the construction and use of economic models to analyze the potential outcomes of the negotiations. The AoA resulted in a complex set of trade policy measures; domestic agricultural policies have become more varied and complex. Economic models can provide insights into the impact of changes in these policies. However, such models must be robust in terms of their economic structure and treatment of policies, and capable of producing credible results that can be communicated to policymakers and the general public.

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