

## **Large Scale CGE Modeling at the United States International Trade Commission**

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**Abstract:** This paper describes the context for the large scale CGE modeling at the United States International Trade Commission and highlights efforts to improve our models to meet customer demands. We describe our role as middlemen between policy modelers and policy makers and the challenges that arise. We summarize the current large scale USITC CGE model and provide a brief history of CGE work at the ITC.

**Key Words:** Computable General Equilibrium Model, policy makers, trade policy models, United States International Trade Commission.

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The goal of this paper is to set the context for the development and use of the new United States Applied General Equilibrium model at the United States International Trade Commission, USAGE-ITC, developed in collaboration with the Center of Policy Studies at Monash University. Our main objective in developing USAGE-ITC is to better meet the demands of the ITC's main customer base, policy makers in the Administrative and Congressional branches of the US government. In part one of this paper we discuss some of the unique challenges the ITC faces in using large scale CGE models. We note the increasing acceptance of CGE policy modeling in the United States, describe how the ITC frequently finds itself serving as a middleman between policy modelers and policy makers, and summarize some of the challenges we face in doing so. In part two of this paper we provide a very brief overview of the major CGE policy modeling effort at the ITC and finally we review the history of CGE modeling at the ITC.

## **Part One: The Use of CGE Models for Policy Analysis at the United States International Trade Commission**

Since the late 1970's applied general equilibrium modeling has been increasingly applied to the quantification of various economic questions. By the mid 1980's numerous volumes were produced describing the development of these models, comparing the consistency of the analysis they generate, and laying the groundwork for their future development. In the Srinivasan and Whalley volume Bhagwati asked the question: "...How can the computable general equilibrium models that have recently come into vogue be utilized to analyze problems of international trade policy?" Srinivasan and Whalley suggested that these models were ready for prime time, with some well placed investments:

While these models are still some distance from the kind of practical implementable policy evaluation tool that can be easily used by policymakers, in our opinion their relevance no longer seems in question. The key issues are parameter values and the forms of model used, rather than the feasibility of applying the models themselves.

Perhaps reflecting the "mainstreaming" of CGE models the ITC started conducting large scale CGE modeling for policymakers in 1991. In the past 11 years the ITC has used CGE analysis 15 times for formal studies, with the pace for formal requests increasing, and also faces increasing demands to use it for informal studies. This has placed the ITC in the position of trying to move CGE models toward a more "practical implementable policy evaluation tool." Our experience over the last 11 years has lead us to focus on particular issues in CGE modeling that our customers seem most interested in, such as disaggregation, data and policy timeliness and relevance, and dynamics.

### **The USITC as Middleman**

The USITC is not a policymaking body. It is however, statutorily mandated to provide objective advice to US policymakers, representing the President and Congress, under specific circumstances (in particular section 332 of the Tariff Act of 1930.) The form of advice the ITC provides to policy makers is typically in the form of research reports which generally are well received by our customers. A recent audit by the USITC's Inspector General of the ITC's research program found that a total of 67 % of ITC customers who responded to their questionnaire found our reports either very useful (42%) or

somewhat useful (25%), that 92% felt that our reports presented new information, 82% felt that we had not missed any important information in the reports, and 96% felt that the Commission analysis added value (see USITC Audit Report). Despite this generally favorable assessment of Commission studies feedback from our policy making customers has often emphasized the need to present analytical results in a more relevant context. It has been made clear to us that the trade policy debate in the United States has become much more fragmented in recent years over winners and losers in different geographic areas, employment categories, and economic sectors, as well as by the nature of potential adjustments in these areas over time. Demand has grown significantly for economic insights on these issues.

US policymakers are often looking for insights as to how policy changes might affect their specific constituents. They often request that the ITC provide detailed descriptions and quantitative estimates of how policy changes in specific economic sectors might affect the US economy. Most large scale economic models operate at a level of abstraction that makes connection to the local difficult, and the rigorous analytical representation of vaguely described policies a challenge. At the ITC we have 3 main policy customers, the House Ways and Means Committee, the Senate Finance Committee, and the United States Trade Representative. They typically ask us to conduct 14 studies per year, and typically give us from 6 weeks to 9 months to conduct a study. For studies involving large scale modeling they typically describe the variables they are interested in, and typically ask us to identify any factors that we could not quantify, and to provide a qualitative description of those factors.

Before asking us to conduct a study our customers typically ask us what we are capable of providing in terms of economic insights. It is here that the disconnect between customer preferences and our analytical abilities is revealed. Typically our customers would like far more detailed economic analysis than most, if not all, economic models can provide. A number of questions usually arise in policy debates - will this policy create more jobs than it will destroy? Which jobs will grow, which will decline, and where? Will gross output and investment increase and if so for which industries and where? Will society be better off in general, and who in particular will win and who will lose? Ideally these questions could be answered at the congressional district level, at a minimum the state level. However, our current analytical frameworks typically give us insights on these issues only at the national level.

It is in this context that the ITC serves as a middleman between researchers developing basic insights and resolving theoretical issues in policy models and the policy maker, who is demanding economic insights in a context determined by their political constituencies. The necessary abstractions and generalizations used by policy modelers must be tightly linked to real world economic and policy settings by researchers doing analysis for the policy makers. Therefore ITC economists depend heavily upon the contributions of policy modelers, but then face significant challenges in generating economic insights in a context more amenable to policy makers.

At the ITC we have found that how the policy analysis is packaged and presented can be as important to policy makers as the underlying quality of the economic insights generated. A challenge for the ITC economist is to successfully address the policy makers contextual demands while at the same time ensuring that the quality of the underlying analysis meets academic standards. For example we have found that base year data that is more than 3 or 4 years old often undermines many policy makers confidence in the analysis, even if more updated data doesn't affect the general thrust of our results.

We have also found that reporting results from comparative static models leaves policy makers unsatisfied, even if dynamic issues were unimportant.

Another area where we have faced skepticism is in parameterization. Policy makers will often significantly discount economic insights from models they feel are not based on the current economy, or they sense have no empirical foundation. One must demonstrate that either the economic insights generated are not particularly sensitive to parameter choice, or provide the range of outcomes that might occur over a reasonable range of estimates.

Finally another major challenge is to present our economic insights on reported variables that more closely align with policy makers' constituent politics. In Congressional policy debate economic information provided at the state level is popular, almost regardless of its quality. Since the ITC's CGE analysis has been conducted at the national and sectoral levels our insights are often overlooked.

In their 1997 book ITC alum Joe Francois and Ken Reinert noted in their introduction that as freshly minted Ph.D.s they arrived at the ITC well trained in "mainstream international economics" and naively thought they had "at least the basics" to work in applied policy (Francois and Reinert). They found that they needed a set of tools that "were rather different from those emphasized in academia." The work of Joe, Ken, and many other ITC and non-ITC economists have made significant progress toward improving applied policy analysis in connecting theory with practice. The current efforts to build the USAGE model continue these efforts.

## **Part Two: Overview of the Existing USITC model**

In this section of the paper we present an overview of the existing USITC model. The objective is to provide the reader with some sense of how the new USAGE-ITC fits in with the existing framework used by the ITC to conduct policy analysis.

There seem to be 4 broad categories of AGE's, fiscal models with a tax focus, development models, environment and energy models, and trade models. A number of publications provide overviews of the major modeling efforts in these areas, among them are *General Equilibrium Trade Policy Modeling* (Srinivasan and Whalley), *Applying General Equilibrium* (Shoven and Whalley), *Using Dynamic General Equilibrium Models for Policy Analysis* (Harrison, Hougard Jensen, Haagen Petersen, and Rutherford), *Joint Committee on Taxation Tax Modeling Project and 1997 Tax Symposium Papers* (Joint Committee on Taxation), *General Equilibrium Models for Development Policy* (Dervis, DeMelo, and Robinson), *The Economy-Wide Modeling of the Economic Implications of a FTA with Mexico and a NAFTA with Canada and Mexico* (USITC, 1992), and *The Major Economic Implications of Liberalizing APEC Tariff and Nontariff Barriers to Trade* (USITC, 1998).

In general terms tax models tend to be single country models, tend to have dynamic specifications, have fairly disaggregated demand and production components, and elasticities drawn from literature searches and best guesses. Energy and environment models tend to be multi-country or regional models, tend to have dynamic specifications, with fairly aggregated demand components and fairly disaggregated production components, and elasticities drawn from literature and best guesses. Trade models tend to

be multi-country, static, with highly aggregated demand components, relatively aggregated production components, and again, elasticities drawn from the literature and best guesses.

The current USITC CGE model is a static, single country model, with a highly aggregated demand component, highly disaggregated production component, detailed policy information on tariffs, and fairly extensive use of econometrically estimated parameters.

A modeling system is inevitably shaped by the policy questions facing the researcher. For example, the USITC model has a relatively complete treatment of international trade with a full treatment of large-economy effects than a tax focused model would generally have. One important feature largely missing from the USITC CGE model is a treatment of regional impacts. As mentioned earlier, the structure of the U.S. government often dictates that legislators and policy makers focus on their constituents in individual states.

The importance of reporting state-by-state impacts has been recognized by many researchers, but to date few trade models include a systematic “bottom-up” compilation of interrelated state economies. Some studies of the NAFTA, for example, apportion national impacts to obtain state-level effects (Almon, KPMG Peat Marwick, and Stern et al.). The apportioning method does have precedent in the literature, but is often met with mixed reviews.

## **The USITC CGE Model**

### *General Scope and Motivation*

The USITC’s CGE model is designed to aid the analysis of changes in trade policy and to measure aggregate welfare as well as detailed sectoral impacts on the U.S. economy (Balistreri and Fox). The model is a large scale representation of the U.S. economy and its trade relationships. In order to facilitate theoretically consistent welfare comparisons, the model assumes consumer utility maximization, subject to primary factor endowments, technological constraints, and trade opportunities. A static welfare analysis is used to examine alternative policies. Furthermore, specific industry impacts are consistently generated. The model specifically reports estimated changes in employment, output, imports, and exports by sector.

### *Final Demand Behavior and Welfare*

Final demand in the USITC model consists of three domestic components and the overall trade balance. The primary domestic component is household demand, which includes the behavioral reaction of consumers maximizing their utility given endowments and market prices. The other domestic components of final demand are government expenditures and real investments. These are generally held fixed, facilitating a consistent welfare comparison that only involves consumer utility.

Household final demand is determined by a linear expenditure system (LES), a generalized form of the Cobb-Douglas utility function (Deaton and Muellbauer). The utility function allows any range of income elasticities. This is accomplished by translating the origin of the standard Cobb-Douglas

function into the positive quadrant -- effectively defining subsistence consumption levels for each of the commodities. Income expansion paths are linear, though the displaced origin means that preferences need not be homothetic. The income elasticities of demand for each commodity and the Frisch coefficient (which establishes the overall expenditure elasticity) are determined outside the model.

Real government demand is fixed exogenously. Although gross receipts from tax and tariff revenues vary across scenarios, a compensating transfer is determined such that gross yield, and therefore expenditure, is maintained. Assuming that the public good provided by the government is separable in utility, fixed real public demand allows for a theoretically consistent welfare analysis despite an inability to quantify the initial contribution of the public goods in utility (see Fullerton or Ballard and Fullerton).

Real investment is also fixed exogenously. This specification avoids dynamic considerations, which greatly simplifies the static welfare comparisons. There is no treatment of consumer preferences through time, nor the dynamics which allow households to delay consumption in an effort to increase future production. Rather there is a constant marginal propensity to save (mps) out of current nominal income. In the counterfactual constant real investment is supported by private and public savings (plus net borrowing from the rest of the world). Public saving adjusts to meet any shortfall (or excess) in private savings.

### *Production Technology*

Production is constant returns to scale with perfect competition. There are zero economic profits such that the total value of commodities made by each industry equals that industry's factor and intermediate purchases. Capital and labor inputs are combined according to a constant elasticity of substitution (CES) value added function. The elasticity of substitution between factor inputs is estimated outside of the model framework. Value-added is combined with intermediate inputs in fixed proportions.

Each production sector corresponds to a single primary good, but joint products are produced when there are off-diagonal elements to the make matrix. That is, there is a possibility that any number of commodities might be produced by a single industry. Joint products are produced in fixed proportions to industry output.

### *International Trade*

There are two general features of international trade of goods and services in the USITC's model. First, the standard Armington formulation of products differentiated by place of origin is utilized. Second, a large open economy (LOE) extension of the standard single country model allows for finite elasticities of import supply and export demand. This is an important feature that captures many of the characteristics of a multi-region model of world trade with limited modeling overhead.

The Armington formulation differentiates goods into three types: two foreign and one domestic. The two foreign source goods are combined in an upstream CES nest that allows the modeler to control

foreign countries that are targeted by a specific policy and those that are not. The foreign composite is then combined with the domestic commodity (via another CES function) to form total commodity supply to the U.S. economy. This nesting structure is convenient when there is reason to believe that targeted regions have a distinct pattern of differentiation relative to non-targeted regions.

Similar to the Armington formulation on the import side, there is a constant elasticity of transformation (CET) function which differentiates domestically produced goods into those destined for home markets and those exported. This formulation produces an increasing cost to penetrating export markets (or to abandoning export markets). The shares of domestic supply and exports are determined in response to relative prices, which do not need to be identical in order to diversify across both.

The model has no features specific to Canada and Mexico. However, the framework does allow the differentiation of targeted and nontargeted countries for trade policy analysis. For example, if one were interested in unilateral tariff removal, Canada and Mexico could be treated as nontargeted, while the rest of the world could be treated as a targeted region.

### *Factor Markets*

There is a single type of labor endowed to households, and the model includes an option to consider a labor-leisure decision by consumers. Labor markets are assumed to clear, but wage differentials are maintained across sectors. The wage differentials are used to scale labor inputs in generic 'efficiency-units' to observed employment by sector. This produces realistic employment reactions in policy cases, but because the model clears in generic labor units, the total number of people employed is not preserved even when there is no labor supply response. However, the number of efficiency units is preserved when the labor supply response is zero.

Capital inputs and endowments are treated similar to labor. Consistent with the static framework for analyzing welfare impacts, capital is owned by households and markets clear such that capital is mobile across sectors and there is a single net of tax rental rate earned per generic unit of capital. Adding-up problems are generally not a problem because there is no single popular metric for measuring physical units of capital by sector (such as employment for labor). Real capital is generally only measured in terms of a value metric: using a constant currency unit to measure the quantity of capital. This naturally measures capital in generic efficiency units. It should be noted, however, that assuming one type of capital does over simplify the inter-sectoral relationships.

The mobility of factors across sectors is an appropriate assumption given the goal of static welfare analysis. The model reflects a long-run equilibrium in which factors are not limited by ties to a specific sector. This is not exactly consistent with a dynamic model in which capital depreciates and is accumulated via investment, because in those models the absolute level of capital adjusts (in addition to the reallocation of capital across sectors). Importantly, a fixed capital endowment in the static model does not reflect the long-run distortions associated with many policy instruments.

## *US Tax System and Other Policy Instruments*

Private households, enterprises, and the government are disaggregated into separate income and expenditure specifications. This makes possible a number of fiscal instruments. The primary focus is on trade distortions. Tariff/tax equivalents of domestically-held or foreign-held quotas may be specified by targeted/nontargeted region. Tariffs may be similarly disaggregated. Export subsidies are also modeled. Both tariffs and export subsidies may be differentiated by destination, using a target country/nontarget split.

Domestically, there are a number of tax instruments: indirect business tax, production subsidy, capital tax, labor tax, and an income tax. The indirect tax can vary by sector, while capital, labor, and income taxes are all fixed rates. There is only one representative household and hence only one marginal rate of capital, labor, and income tax.

Tax rates are determined by accounting flows. This generally underestimates the distortions, because marginal tax rates exceed average rates (especially for income and direct capital taxes). This is not problematic in the case of capital because it is inelastically supplied (capital taxes are non-distortionary by construct), and it is only problematic for labor and income when labor is elastically supplied.

## *Data Sources*

The 487 sector Social Accounting Matrix (SAM) used to calibrate the USITC model is constructed from two primary data sources:

1. A Macro SAM constructed from the Bureau of Economic Analysis, U.S. Department of Commerce (BEA) National Income and Products Accounts of the United States (NIPA). These data outline the overall scale of the economy in the 'target year' of calibration.
2. An Input-Output (I-O) table describing the detailed flow of payments among sectors and agents. Most recently the ITC has utilized the BEA I-O tables, while previous generations of the ITC SAM were based on IMPLAN data.

The Input-Output data is released less frequently and may not in general be consistent with the NIPA accounts. In order to match data from different years the ITC has built routines that 'grow' the I-O tables to the target year. Value added contributions at the sectoral level have to be brought in from previous benchmark BEA I-O tables, because benchmark tables are produced less frequently than the standard I-O tables, which do not decompose value added into labor, capital, and indirect tax payments by firms. The data compilation and manipulation procedures are well documented by Johnson, Parks, and Reinert.

## *Parameters*

In parallel with the SAM, the USITC compiles behavioral parameters in a separate database. The construction of the parameters and the values used are well documented by Reinert and Roland-Holst (1991), and for recent Armington elasticities, by Gallaway, McDaniel, and Rivera. The parameter

database has the same level of initial disaggregation as the SAM, and is recompiled when the SAM is aggregated up for a particular policy analysis. Parameter values come from two primary sources: literature estimates and estimates made internally at the ITC. In general estimates for most agricultural goods are borrowed from the USDA/ERS model (Robinson, Kilkenny, and Hanson), and estimations involving trade data are done in-house at the ITC. Inevitably, some estimates could not be made, or found in the literature, and are therefore set to ad hoc yet reasonable levels.

Like most CGE models, an arbitrary rule is used to eliminate domestic-import complementarities and other unrealistic characteristics implied by single equation, direct estimates of the Armington elasticity. The method used here is consistent with that used in the GTAP model. The parameters used in the GTAP model are determined by finding the harmonic mean between the econometric estimates of the elasticity of substitution and a prior belief that the elasticity is 5 (Industry Commission).

Constant elasticity of transformation parameters are borrowed from the USDA and ITC estimates (except for services which are set arbitrarily to 1.1). Specific estimates for the import supply and export demand functions are made by the ITC. Expenditure elasticity and Frisch parameter estimates for calibrating the utility function are taken from the literature (see pages 12 and 13 of Reinert and Roland-Holst (1991) for the extensive list of citations). Elasticities of substitution between capital and labor are taken from Balistreri, McDaniel, and Wong.

## **History of CGE Research at the ITC**

In conducting CGE research and analysis, the ITC currently relies primarily on its own in-house CGE model of the US economy and on the multi-country GTAP model. This section describes how the Office of Economics (OE) developed its U.S. model, the role of the GTAP model within ITC research and analysis, other avenues of applied general equilibrium activity, and finally, the direction of future research in this area. The discussion of ITC studies in this section serves more as a catalogue rather than an assessment of this mainly empirical research and its findings.

### *US Model*

The ITC began exploring the development of an in-house, single country CGE framework in the late 1980s. Requests by Congress and the United States Trade Representative (USTR) to examine the effects of trade policy on an economy-wide basis, with special emphasis on the upstream and downstream effects of such policies were the motivating force. Early attempts by the ITC to address economy-wide questions entailed the use of an input-output framework; however, the staff found the results of these efforts somewhat incomplete and decided to migrate toward a US CGE framework similar to that being developed for the Economic Research Service of the U.S. Department of Agriculture (USDA).

In 1989 the ITC was asked by the Senate Finance Committee to conduct a three-year study to explore the effects of significant U.S. import restraints. The Commission hired an outside consultant to develop a highly disaggregated CGE model of the U.S. economy. A 489-sector model was completed and used in the final phase of the three-year study in 1991 (USITC, 1991(a), 1991(b)).

With the CGE framework, the Commission was able to inform policy makers on the potential welfare gains to the economy that might occur from simultaneously removing significant U.S. import restraints, approximately \$9.5 billion. The series of reports was found useful by the requester. As a result, the USTR requested that the Commission repeat a similar study every two years examining and updating the effects of significant U.S. restraints using the U.S. CGE framework.

The U.S. model has been used primarily in this series of updates looking at significant U.S. import restraints and is currently being used in the third update which will be released to the public in June 2002. The two exceptions where the model has been used to examine other trade policy topics were a study that assessed the cost of antidumping and countervailing duties on the U.S. economy (USITC, 1995) and another one that examined the effects of foreign shipbuilding subsidies on maritime transport costs for disaggregated U.S. sectors (USITC, 1992). Policymakers have found the *Import Restraints* reports extremely useful in discussions with the United States' WTO trade partners on the transparency and cost of U.S. trade barriers. More recently, this report has had a highly visible position in Congress' examination of the effects of the Jones Act on the U.S. maritime sector (U.S. GAO).

In addition to the statutory work, the U.S. CGE model and its social accounting were the basis for a collection of research conducted by economists within the Research Division of the Office of Economics. These studies have included a wide variety of topics, ranging from textile and apparel protection to structural change in the U.S. economy. Table 1 lists both the statutory investigations and other research papers based on the U.S. model.

### *GTAP Model*

The ITC undertook to develop its capabilities with respect to multi-country CGE models in the mid-1990's. The immediate reason for developing these capabilities arose from a technical-assistance request from policymakers in 1994 to examine the potential effects of the GATT Uruguay Round using a global CGE framework. To meet this request, the Commission worked with Purdue University's GTAP group to examine the Uruguay Round. This analysis and subsequent utilization of the relatively user-friendly GTAP model led to the Commission becoming a GTAP Consortium member in 1997.<sup>1</sup>

Over time, this model has become an important tool for ITC staff and has been used in a wide number of fact-finding studies and technical assistance exercises for both Congress and the USTR. The framework has been used by the ITC primarily to examine the potential effects of various regional trade agreements, such as the EU-South Africa FTA, accession of the UK to NAFTA, and a US-Korea FTA. Table 2 contains a list of ITC statutory studies that have made use of the GTAP model. Finally, in addition to these fact-finding studies, a variety of papers were written by OE economists using GTAP on such varied topics as liberalization in agricultural sectors (Tsigas and Tsigas and Ingco), an EU-South Africa FTA (Andriamananjara and Hillberry), and US MFN status for China (Arce and Taylor).

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<sup>1</sup> See Hertel for further discussion on the GTAP model.

## *Other CGE Activities*

In addition to its experience with the US CGE and GTAP models, OE has also conducted other studies or research that relied heavily on applied general equilibrium modeling or that have added to the knowledge of parameters used in these types of models. This research has entailed sponsoring two symposia -- one on the effects of NAFTA and the other on the effects of APEC -- that contained substantial CGE modeling. In addition, considerable research has been conducted on econometrically estimating the value of Armington parameters as well as other parameters used in CGE models. (Table 3 lists the papers resulting from the efforts to estimate these parameters.) While the remainder of this section focuses on the two symposia and the parameter estimates, it should be noted that OE economists have conducted other assorted research focusing on various trade issues within a CGE context. These papers have examined topics such as trade policy and employment, the work-leisure choice, and the role of services in production and trade, to name a few. (Table 4 lists ITC papers covering assorted CGE work.)

In 1992, the Commission hosted a symposium on the economy-wide effects of a North American Free Trade Agreement (NAFTA).<sup>2</sup> The symposium, which was organized at the request of USTR, focused on 12 economy-wide analyses of NAFTA. With the exception of one of these papers, all of the analyses were conducted using CGE models. The one exception was based on a linked macroeconomic forecasting model. The symposium organizers attempted to include nearly all of the CGE research that was then engaged in assessing the effects of NAFTA. At the time, CGE models were a relatively new application to trade policy analysis. As the report noted, “the public debate over NAFTA represents the first time this new class of economic models has been featured prominently in the public debate on US trade policy.” (USITC, 1992(a), p. v.)

The analyses presented at the symposium covered four broad categories: static CGE models with fairly broad sectoring schemes, dynamic CGE models, CGE models focused on specific sectors such as autos and agriculture, and, finally, the linked macroeconomic model. The analyses examined a number of different scenarios and were able to simulate the effects associated with the liberalization of tariffs and nontariff barriers (NTBs), increased financial capital flows, and accelerated growth rates associated with openness. While these models were fairly varied, they all showed relatively similar conclusions. In general, the analyses found the likely effects of NAFTA to be positive for the three countries, with the largest gains realized by Mexico.

In 1997, the USTR requested that the Commission organize a second symposium on barriers to trade and investment in the APEC economies. The Commission was asked to focus on research pertaining to “various public and private policies and practices, as well as on the general equilibrium modeling of trade policy.” (USITC, 1997, p. iii.) The symposium was comprised of 20 papers all within an APEC context covering broad topics such as trade policy measures, deregulation, business networks, services and intellectual property rights, public practices, and CGE modeling of barriers.

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<sup>2</sup> See USITC, 1992(a). The report to USTR is organized in two volumes: the first is a summary and critical review (USITC publication 2516) and the second is an addendum of all the papers and discussants’ comments (USITC publication 2508).

Of the 20 papers, six were CGE analyses of APEC trade liberalization. The CGE papers were grouped into three main topics: overall APEC liberalization, services liberalization, and dynamic analyses. Overall, the most general liberalization scenarios suggested that APEC would obtain static gains of approximately 1 percent of GDP. Some of the more specific topics addressed included trade facilitation measures,<sup>3</sup> trade externalities,<sup>4</sup> regulation costs, and financial capital flows within APEC.

One of the more important areas of CGE research at the ITC focuses on the estimation of the behavioral parameters used in these types of analyses, specifically elasticities of substitution between imported and domestic goods (Armington elasticities) and capital-labor substitution elasticities. Most of this research has focused on obtaining parameters for use in the ITC's US CGE model. However, during the NAFTA debate, efforts were directed towards obtaining Armingtons for analysis of the Agreement.

As part of the efforts in building the US CGE model, Reinert and Roland-Holst (1992 (b)) were among the first, both at the ITC and in general, to econometrically estimate constant elasticity of substitution (CES) elasticities for the US economy, specifically, for 163 mining and manufacturing sectors. The paper found statistically significant estimates of Armingtons for most of the sectors, ranging from 0.1 to 3.5. Almost a decade later, Gallaway, McDaniel, and Rivera (GMR) estimated short- and long-run Armington elasticities for 311 US industries. These short-run estimates in GMR were similar in magnitude to those found in Reinert and Roland-Holst; however, the long-run Armingtons were almost double in magnitude.

Other Armington papers by Hillberry, et al. and McDaniel and Balistreri have examined the implication of using the current set of Armington estimates in CGE trade policy analyses. Among the Armington papers by Shiells and Reinert (1992, 1993), the first focused on measuring CES elasticities between US products and imports from Canada and Mexico in the US market for 163 mining and manufacturing sectors, while the second focused on the terms-of-trade effects resulting from these estimates.

Finally, Balistreri, McDaniel, and Wong focus on estimating short- and long-run elasticities of substitution between capital and labor for 28 US industries. Their findings lend support to the Cobb-Douglas specification for this parameter. Future updates and refinements as well as increased efforts to better understand the interaction of these behavioral parameters is a substantial portion of OE's research agenda for the future.

### *Future Research*

In 2001, OE launched three ambitious projects aimed at expanding its CGE capabilities. These projects included the expansion and refinement of its US CGE model, the construction of a Russia model, and improvement of the NTB measurements that are used within these models. The expansion of the US model -- renamed the US Applied General Equilibrium-ITC (USAGE-ITC) model -- is being conducted

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<sup>3</sup> In addition to tariffs and traditional NTBs, trade facilitation measures such as customs procedures, divergent standards, and technical and other regulations were also examined.

<sup>4</sup> The term refers to changes in an economy's structure, such as technology or productivity enhancements, that could result from increased levels of trade.

in collaboration with economists from Monash University. Collaborative efforts also were undertaken with economists from Moscow State University to build a model of the Russian economy to examine the implications of Russia's WTO accession. The NTB project will attempt to catalogue and quantify the major NTBs for major US trading partner. In addition to increasing the usefulness of current protection databases, an important goal of this project is to provide the USTR and Congress with a more complete assessment of the potential effects of various bilateral and multilateral trade agreements.

## **Conclusions**

The ITC faces numerous challenges in its role as a middleman between policy modelers and policy makers. Many of the kinds of economic insights policy makers demand go well beyond the typical detail provided by policy modelers. This leaves the ITC with a large research agenda focusing more on highly detailed, highly disaggregated applied models with an extensive empirically estimated parameter set. While these characteristics are not highly valued by journal editors or tenure committees they are of critical importance to policy makers. The documentation of the current large-scale CGE model at the ITC illustrates the ITC's efforts to meet their demands. A review of the recent history of ITC research illustrates the kinds of policy questions we're asked and the empirical efforts we put into policy models. Our current effort in constructing the new USAGE-ITC model continues on the path of building a high quality policy model that produces model results relevant to policy makers.

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**Table 1—Research based on U.S. CGE Model**

Title	Authors	Publication
The Economic Effects of Significant U.S. Import Restraints	USITC	USITC pubs. 2422 (1991), 2699 (1993), 2935 (1995), 3201 (1999)
A Detailed Social Accounting Matrix for the United States: 1988	Reinert and Roland-Holst	<i>Economic Research Systems</i> , (4,2) 1992
Structural Change in the United States: Social Accounting Estimates for 1982-1988	Reinert and Roland-Holst	USITC/OE Working Paper No. 91-03-A, Mar. 1991
Shipbuilding Trade Reform Act of 1992: The Likely Economic Effects of Enactment	USITC	USITC pub. 2495 (1992)
Textile and Apparel Protection in the United States: A General Equilibrium Analysis	Reinert	<i>World Economy</i> , Vol. 16:3, 1993
The Welfare and Resource Allocation Effects of the U.S. Dairy Quotas	Flynn and Reinert	<i>International Economic Journal</i> , Vol. 7:2, 1993
A Computable General Equilibrium Estimation of the Effects of the U.S. Meat Program	Berg and Reinert	USITC/OE Working Paper No. 93-11-A, Nov. 1993
A Note on Aggregation and the Welfare Analysis of Tariffs: Evidence from the United States	Arce and Reinert	<i>Journal of Economic Studies</i> , Vol. 21:6, 1994
The Economic Effects of Antidumping and Countervailing Duty Orders and Suspension Agreements	USITC	USITC pub. 2900 (1995)
Commercial Policy and the Domestic Carrying Trade: A General Equilibrium Assessment	Francois, Arce, Reinert, and Flynn	<i>Canadian Journal of Economics</i> , Vol. 29:1, 1996
Multicountry Results from a Single-Country Model: The Case of U.S.-Chilean Trade Liberalization	Gallaway and Linkins	USITC/OE Working Paper No. 96-09-A, Sept. 1993

Source: USITC.

**Table 2-- ITC statutory studies using GTAP**

Study topic	Requester
An FTA between the United States and the European Union (classified)	USTR
China's accession to the WTO <sup>1</sup>	USTR
U.S. sanctions on India and Pakistan	Congress
The United Kingdom joining NAFTA	Congress
The Andean Trade Preference Act	Congress/President
An FTA between the European Union and South Africa (classified)	USTR
An FTA between the United States and Singapore (classified)	USTR
An FTA between the United States and Chile (classified)	USTR
An FTA between the United States and Korea	Congress

<sup>1</sup> Only the GTAP database was used in this analysis.

Source: USITC.

**Table 3—Research on CGE Parameters**

Title	Authors	Publication
Disaggregated Armington Elasticities for the Mining and Manufacturing Sectors of the United States	Reinert and Roland-Holst	<i>Journal of Policy Modeling</i> , Vol. 14:5, 1992
Estimated Elasticities of Substitution for Analysis of a North American Free Trade Area	Shiells and Reinert	USITC Staff Research Study 19, 1992
Armington Models and Terms-of-Trade Effects: Some Econometric Evidence for North America	Shiells and Reinert	<i>Canadian Journal of Economics</i> , Vol. 26:2, 1993
Industry-Level Estimates of U.S. Armington Elasticities	Gallaway, McDaniel and Rivera	USITC/OE Working Paper No. 00-09-A, Sept. 2000
The Determinants of Armington Taste Parameters in CGE Models, or Why You Love Canadian Vegetable Oil	Hillberry, Anderson, Balistreri and Fox	USITC/OE Working Paper No. 01-07-C, July 2001
A Discussion of Armington Trade Substitution Elasticities	McDaniel and Balistreri	USITC/OE Working Paper No. 02-01-A, Jan. 2002
An Estimation of U.S. Industry-Level Capital-Labor Substitution Elasticities: Cobb-Douglas as a Reasonable Starting Point?	Balistreri, McDaniel and Wong	USITC/OE Working Paper No. 01-12-A, Jan. 2002

Source: USITC.

**Table 4—Assorted CGE Research**

Title	Authors	Publication
Estimating the Welfare Cost of U.S. Tariffs: The Role of the Work-Leisure Choice	Rousslang and Tokarick	USITC/OE Working Paper No. 91-01-G, Jan. 1991
United States Adjustments in the 1990s: A CGE Analysis of Alternative Trade Strategies	Hanson, Robinson, and Tokarick	<i>International Economic Journal</i> , Vol. 7:2, 1993
Discriminatory Export Taxation in Costa Rica: A Counterfactual History Using Applied General Equilibrium Analysis	Reinert	USITC/OE Working Paper No. 91-06-A, June 1991
Modeling a North American Free Trade Area: Estimation of Flexible Functional Forms	Shiells, Roland-Holst, and Reinert	<i>Weltwirtschaftliches Archiv</i> , Vol. 129: 1, 1993
The Role of Services in U.S. Production and Trade: An Analysis of Social Accounting Data for the 1980s	Dighe, Francois, and Reinert	<i>The Services Productivity Challenge</i> , P. Harker, editor, Kluwer Press, 1996
North American Trade Liberalization and the Role of Nontariff Barriers	Reinert, Roland-Holst, and Shiells	USITC/OE Working Paper No. 92-03-D, Mar. 1992
Social Accounts and the Structure of the North American Economy	Reinert, Roland-Holst, and Shiells	<i>Economic Systems Research</i> , Vol. 5:3, 1993
Trade Policy and Employment in General Equilibrium	Thierfelder and Shiells	<i>Applied Methods for Trade Policy Analysis</i> , Cambridge University Press, 1997
Free Trade with Chile May Increase U.S. Investment Opportunities in Latin America (Background Information for CGE Policy Simulations)	Benjamin and Pogany	USITC/OE Working Paper No. 96-06-A, June 1996
Computable General Equilibrium Models: An Historical Perspective	Pogany	USITC/OE Working Paper No. 96-09-B, Sept. 1996
Integration and Competitiveness in the Americas: A General Equilibrium Model for Analysis	Benjamin and Pogany	USITC/OE Working Paper No. 97-06-A, June 1997
Liberalizing Services Trade in APEC	Benjamin and Diao	USITC/OE Working Paper No. 97-09-A, Sept. 1997

Source: USITC.