

AN INTRODUCTION TO THE ITC COMPUTABLE GENERAL EQUILIBRIUM MODEL

ADDENDUM TO THE ECONOMIC EFFECTS OF SIGNIFICANT U.S. IMPORT RESTRAINTS

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Section 332 of the
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CHAPTER 1

INTRODUCTION

In 1989 the U.S. International Trade Commission (ITC) staff recognized the need to acquire economywide modeling capabilities in order to meet its obligations under section 332 of the Tariff Act of 1930. To this end, the Commission staff undertook the construction of the ITC Computable General Equilibrium (CGE) Model. The staff's goal was to develop a consistent analytical framework and database for simulating the economywide effects of U.S. commercial policy. Part 2 of the report *The Economic Effects of Significant U.S. Import Restraints, Phase III: Services*, which is entitled "A Computable General Equilibrium Analysis of Significant U.S. Import Restraints," represents the first application of the ITC CGE model under a section 332 request. Recognizing that the model represents a significant expansion of the Commission's research tools, this addendum provides an introduction to its structure and use.

Much of the work undertaken by the Commission concerns very narrow product categories without important linkages to other sectors of the economy. For this type of analysis, single-sector models such as those described in a previous Commission publication (Rousslang and Suomela (1985)¹) are the correct analytical tool. A growing portion of the Commission's work, however, concerns wider product categories with important linkages to other sectors of the economy (e.g. steel, industrial chemicals, and textiles) or simultaneous changes in policies across many sectors (e.g. an across-the-board tariff cut). For this type of work, a single-sector model is not adequate. The correct analytical tool is a multisectoral, economywide model. Such models were developed in the 1970s and are now referred to as computable general equilibrium or CGE models.

CGE models are specifically designed to address the intersectoral effects of policy changes, including simultaneous policy changes in a number of sectors. Early applications addressed tax policy (Shoven and Whalley 1972), commercial policy (Shoven and Whalley 1974, de Melo 1978, and Taylor and Black 1979), economic development (Adelman and Robinson 1978), and energy policy (Hudson and Jorgenson 1978). Since these early applications, CGE models have been widely employed in all four of these policy areas. Published surveys of CGE studies can be found in Shoven and Whalley (1984), Borges (1986), Srinivasan and Whalley (1986), Bergman (1988), Pereira and Shoven (1988), de Melo (1988), and Robinson (1988).

CGE models have been applied to over 30 countries and economic communities. They have been used extensively by the World Bank, and the OECD is in the process of constructing one CGE model for each of its member countries as well as a world model. The Australian Government routinely uses a large CGE model, the ORANI model, to assess the impacts of all proposed policy changes and to advise the prime minister. The ORANI model has become a focal point in public debate over Australian economic policy. The Canadian and Mexican Governments employ CGE models to support their trade negotiations with the United States.

In the area of U.S. trade policy, CGE modeling has been supported by the U.S. Department of Labor (Goulder and Eichengreen 1988), the Federal Trade Commission (Tarr 1989),² and the U.S. Department of Agriculture (Robinson, Kilkenny, and Hanson 1990). While the ITC CGE model is similar to these efforts in broad structure, it has its own special features. Due to the nature of the analyses the Commission supplies to the Congress and President on commercial policy issues, the ITC CGE model has been designed to be as current as possible while providing as much sectoral detail as possible. The model draws on a 487-sector database for the year 1988.³ This database allows the ITC analyst to maintain the sectoral detail often required of ITC studies, while staying within the analytical structure of multisectoral, economywide analysis.

This addendum provides an introduction to the ITC CGE model and summarizes its potential usefulness for analyzing U.S. commercial policy. Chapter 2 provides an introduction to CGE models and their application to policy analysis. Chapter 3 describes the various components of the ITC CGE model and their use in a flexible aggregation approach to commercial policy modeling. Finally, chapter 4 describes an application of the ITC model to the strengthening of a particular tariff. A technical description of the model specification can be found in appendix A. Appendix B lists the 487 sectors that structure the model database. The document closes with a bibliography of all literature cited in the text and appendixes.

¹ Full citations to references in the text of this report may be found in the bibliography. Multiple publications by an author are distinguished by the year of publication.

² See also de Melo and Tarr (1990).

³ The database soon will be updated to the year 1989 with subsequent updates undertaken on a 2-year basis.

CHAPTER 2

WHAT IS A CGE MODEL?

Computable general equilibrium or CGE models simulate the interactions among producers and consumers within a particular economy or group of economies in markets for goods, services, labor, and physical capital. The distinguishing feature of a CGE model is its economywide coverage and multisectoral nature. A large and growing body of evidence suggests that indirect and economywide effects of commercial policy changes, such as upstream and downstream production linkages, intersectoral competition for labor and capital, and exchange rate changes, are very important. CGE models provide a means of explicitly accounting for these effects.

In CGE models, an equation system is solved for prices that equate supply and demand in all markets and satisfy the accounting identities governing economic behavior. Once the equation system has been specified, the equilibrium is calibrated to a data set representing the economy in the base year. When calibrated, the model reproduces the base-year economy in the absence of any policy changes. The calibration process ensures that subsequent policy simulations take off from an initial position that accurately describes the economy and its accounting identities.

After calibration, the CGE model is used to simulate the effects of alternative policies on the economy with reference to the base year. The model fully captures the flow of income from firms to labor and capital, from labor and capital to households, and from households back to firms as consumer demand. Hence, it remains internally consistent even after introducing a policy change.

The policy parameters included in a CGE model include tariffs, quotas, and various domestic taxes, such

as income taxes and indirect business taxes. With a calibrated model in hand, the analyst simulates the effects of proposed policy changes by comparing the base year model solution with a counterfactual model solution in which one or more of the policy parameters has been changed. The new, counterfactual equilibrium accounts for all the changes in the economy that arise as a result of the tax, tariff, or quota change. A comparison of the base-year and counterfactual equilibria reveals the effects of the policy change on:

1. imports,
2. exports,
3. domestic production,
4. employment,
5. wages, and
6. aggregate economic welfare.

Policy changes introduced into CGE models are simulated as though there are no changes in other macroeconomic parameters such as monetary policy, fiscal policy, and foreign economic activity. This reflects a focus on the effects that can be attributed to a specific set of policy changes. Many factors that will affect the actual state of the economy are therefore ignored. For this reason, CGE models do not attempt to forecast what actually will happen as a result of a policy change. Rather, the model provides a numeric assessment of the adjustments in the economy implied by the specific policy change being examined. Since CGE models give us an idea of what *would have happened* to the economy in the base year if the policy change had been in effect, the analyst is able to isolate the effects of the policy under scrutiny from the many other types of economic policies.

CHAPTER 3

THE COMPONENTS OF THE ITC CGE MODEL

As with single-market models, the validity of CGE model policy simulations depends upon three things: accurate share parameters, accurate behavioral parameters, and reasonable model formulation. For the ITC CGE model, we obtained

the most empirically sound share and behavioral parameters available. Share parameters are obtained by calibrating the model to a social accounting matrix. Behavioral parameters are obtained either from original econometric estimation or from the economic literature and are maintained in a separate database. This chapter describes these two databases as well as the model formulation. It also presents the flexible aggregation approach to linking the parameters with the model formulation in any particular policy application.

The ITC Social Accounting Matrix

The empirical foundation of the ITC CGE model is the ITC Social Accounting Matrix or "SAM," constructed for the year 1988.⁴ This SAM is currently being updated to 1989 and subsequently will be adjusted in 2-year intervals to reflect ongoing changes in the U.S. economy. At the heart of the SAM are estimated input-output accounts for 487 sectors in agriculture, manufacturing, and services.⁵ Also incorporated into the SAM are detailed U.S. import data. To achieve economywide consistency of the SAM, the input-output and other data are reconciled with the national income and product accounts (NIPA), yielding a consistent set of detailed transactions between firms, households, government, and other domestic and foreign institutions. A detailed description of the construction of the ITC SAM is presented in Reinert and Roland-Holst (1991a). The ITC SAM composes the base-year dataset for the ITC CGE model. The share parameters of the model are calculated by calibrating the model to the ITC SAM.

The ITC Behavioral Parameter Dataset

While the ITC SAM provides information on the initial equilibrium of the U.S. economy, the behavioral parameters help the model determine how the economy moves from this equilibrium in response to changes in policy parameters. Each behavioral parameter consists of an elasticity. This denotes the percent change of one economic variable that occurs in response to a 1-percent change in another economic variable. For example, an income elasticity of demand is the percentage change in demand that occurs in response to a 1-percent change in household income.

⁴ An introduction to social accounting matrices is given by King (1985).

⁵ Input-output accounts detail the interindustry transactions of the economy, such as the purchase of coal by the steel sector and steel by the automobile sector.

The behavioral parameters required by the model are the following:

1. Elasticities of substitution between imported and domestic goods;
2. Elasticities of transformation between domestic and export goods;
3. Elasticities of import supply;
4. Elasticities of export demand;
5. Elasticities of substitution between labor and capital;
6. Elasticities of labor supply; and
7. Income elasticities.

Where possible, these parameters have been obtained through staff econometric estimation. For example, the elasticities of substitution between imported and domestic manufactured and mining goods are taken from Reinert and Roland-Holst (forthcoming). Where it has not been possible to estimate the parameters, we have relied on published studies for estimates. The parameters are collected into a behavioral parameter dataset, which is continually improved and updated. The behavioral parameter dataset is described in more detail in Reinert and Roland-Holst (1991b).

Model Formulation

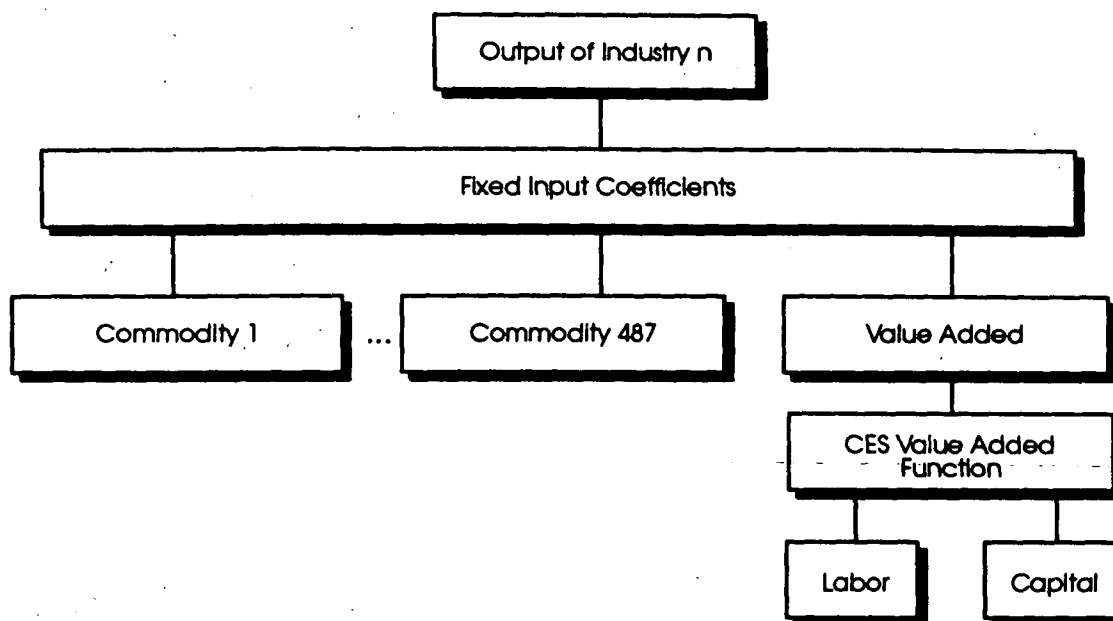
We next turn to the current formulation of the ITC CGE model. This is the mathematical representation of the economy as a system of equations. The formulation will be described in general terms, beginning with the components of domestic final demand. A more complete treatment of the model formulation is given in appendix A.

The ITC CGE model includes three separate components of domestic final demand: household consumption, government demand, and investment demand. Household consumption is represented by a linear expenditure system or LES,⁶ which allows income elasticities of household demand to vary between sectors. The formulation of government demand is such that the analyst can fix total government spending in either nominal or real terms. For investment demand, real investment is held constant. This specification precludes questions concerning the substitution between present and future consumption, which would make it difficult to assess the effects of policy changes on overall economic welfare.

Production is modeled using the approach presented in figure 1. Producers can substitute between the labor and capital components of value added according to a constant elasticity of substitution (CES)

⁶ For an introduction to the LES, see ch. 11 of Silberberg (1990).

Figure 1
Production in the ITC OGE model



value added function.⁷ Intermediate inputs are used in fixed proportions to value added.

The model maintains the base-year level of total physical capital in all policy experiments. The same treatment can be applied to labor, or the analyst can choose to have labor supply vary with wage rates. In either case, wages and capital rental rates adjust to equate supply and demand in labor and capital markets.

We next turn to trade behavior. The model views each sector as consisting of three goods, where imports and exports in each sector are imperfect substitutes for their domestic counterparts.⁸ On the import side, the model treats foreign and domestic goods as imperfect substitutes in domestic demand. Therefore, the import composition of domestic demand is influenced by domestic and import prices. Import restraints influence import demand via import prices. On the export side, the model assumes that domestic firms allocate their output between domestic and foreign markets in response to domestic and export prices. Commercial policy changes can affect exports via the exchange rate.

Finally, we characterize the foreign sector. The model allows for import prices and export prices to vary in response to changing U.S. import demand and export supply, respectively, in those sectors where evidence exists that this response is important.

⁷ Value added is the contribution of labor and capital to the value of a product on top of the value of intermediate inputs. For an introduction to CES functions, see ch. 9 of Silberberg (1990).

⁸ This treatment of traded goods follows de Melo and Robinson (1989).

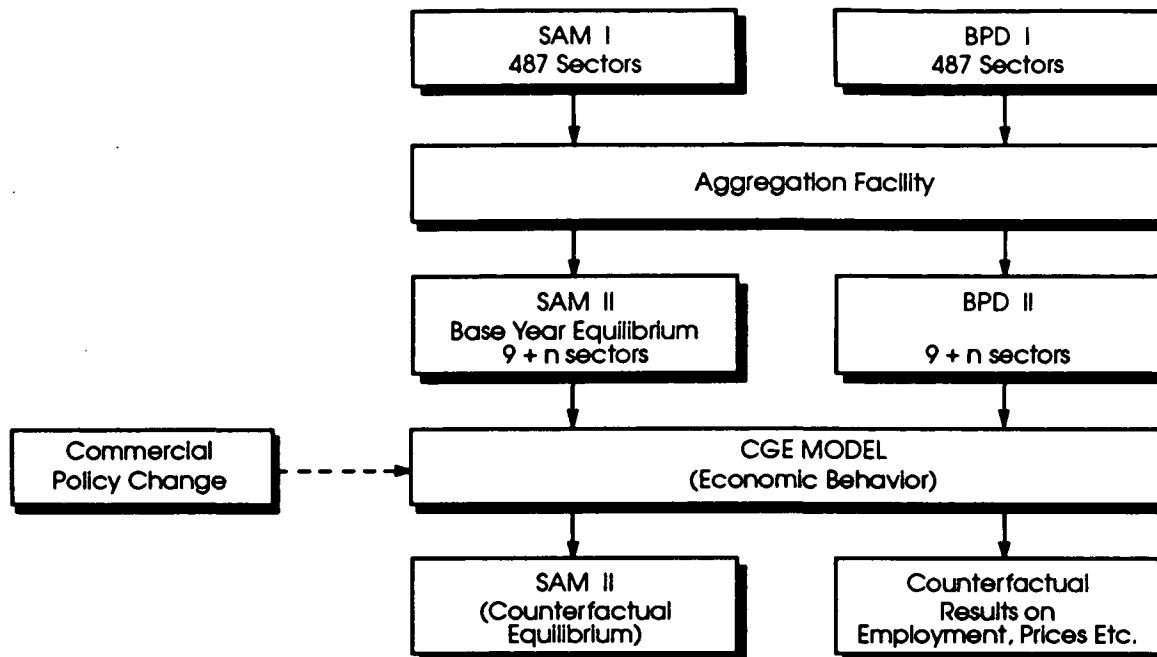
The Flexible Aggregation Facility

The roles of the social accounting matrix, the behavioral parameter dataset, and the flexible aggregation facility in supporting CGE modeling of trade policy are represented in figure 2. The fully disaggregated ITC SAM is denoted as SAM I in this figure, and the fully disaggregated behavioral parameter dataset is denoted BPD I. The aggregation procedure involves choosing n focus sectors. The remainder of the economy is then aggregated into 9 reference sectors. Aggregation into the resulting $9 + n$ sectors results in SAM II and BPD II. SAM II is the base-year dataset for the project-specific CGE model. The ITC CGE model is calibrated to this dataset using the exogenous behavioral parameters in BPD II. The analyst introduces a commercial policy change, such as a tariff cut, and the behavioral model simulates the response of the economy to this policy change. This results in a counterfactual equilibrium that can be expressed as a new SAM, denoted SAM III. The model also produces a large volume of subsidiary counterfactual results on changes in employment, prices, and other real and nominal economic variables.

To illustrate what SAM II for the United States might look like, an aggregation for the nine reference sectors alone is presented in table 1. The nine reference sectors are:

1. Agriculture, forestry, and fishing
2. Mining and mineral resources
3. Construction
4. Nondurable manufacturing
5. Durable manufacturing

Figure 2
The flexible aggregation approach to CGE modelling



6. Transportation, communication, utilities
7. Wholesale and retail trade
8. Finance, insurance, and real estate
9. Personal, business, and public services.

These sectors make up accounts 1-9. Additionally, there are 10 other accounts. There are two factor accounts: labor (account 10) and property (account 11). Account 12 is the enterprise account. Enterprises collect gross profits and government transfers and distribute them to other accounts. Accounts 13 and 14 are the household and government accounts, respectively. Account 15 is the capital account, which closes the system of income-expenditure flows. Account 16 is the rest of the world account (ROW), which records international transactions. Account 17

collects tariffs and distributes them to the government. Accounts 18 and 19 are the errors account and the total account, respectively.

Columns 1-9 of table 1 give the expenditures of the commodity account. Rows 1-9 of these columns are expenditures on intermediate inputs. Rows 10, 11, and 14 are expenditures on labor, property, and indirect business taxes, respectively. These are the three components of value added. Row 16 gives expenditures on imports, and row 17 gives tariff payments.

Columns 10-17 of table 1 give the expenditures by the institutional accounts. Rows 1-9 of columns 13-16 give final demand expenditures including exports (column 16). Rows 10-17 give interinstitutional transfers which are a part of the U.S. National Income and Product Accounts.

Table 1
A Reference SAM for the United States, 1988.

(Millions of dollars)

| | 1. agforsh | 2. mining | 3. construct | 4. ndurmfg | 5. durmfg | 6. trcomut | 7. trade | 8. fininsre | 9. services |
|----------------|------------|-----------|--------------|------------|-----------|------------|----------|-------------|-------------|
| 1. agforsh | 42174 | 7 | 2408 | 98260 | 7783 | 74 | 2683 | 7610 | 6565 |
| 2. mining | 68 | 9626 | 2244 | 81959 | 8091 | 34823 | 1 | 25 | 25 |
| 3. construct | 1806 | 11668 | 625 | 6767 | 8747 | 20927 | 5527 | 35989 | 17626 |
| 4. ndurmfg | 29973 | 1015 | 34995 | 370421 | 83276 | 37101 | 24004 | 14290 | 149157 |
| 5. durmfg | 4073 | 2594 | 174911 | 54660 | 479542 | 18816 | 7494 | 4395 | 80976 |
| 6. trcomut | 4511 | 1240 | 16564 | 66440 | 64757 | 78291 | 45619 | 30976 | 83618 |
| 7. trade | 8202 | 753 | 72451 | 57265 | 72983 | 10949 | 13764 | 7129 | 49736 |
| 8. fininsre | 10083 | 2667 | 9646 | 17949 | 25210 | 14466 | 51925 | 193663 | 79024 |
| 9. services | 4989 | 1410 | 52562 | 68116 | 74358 | 30890 | 123868 | 93098 | 213502 |
| 10. labor | 32505 | 18242 | 197013 | 218389 | 429879 | 211905 | 384751 | 217417 | 1197545 |
| 11. property | 60036 | 55682 | 31662 | 141784 | 68905 | 207225 | 146709 | 511312 | 332442 |
| 12. enterprise | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13. household | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14. government | 7755 | 11736 | 7014 | 27723 | 18290 | 35207 | 126693 | 113027 | 29621 |
| 15. capaccount | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16. row | 8167 | 31302 | 0 | 114621 | 294959 | 74768 | 0 | 11769 | 2315 |
| 17. rowtaxes | 176 | 192 | 0 | 3341 | 7739 | 0 | 0 | 0 | 0 |
| 18. error | -222 | -189 | -521 | -858 | -1144 | -1005 | -1456 | -1862 | -2344 |
| 19. total | 214296 | 147945 | 601574 | 1331837 | 1643375 | 774437 | 931582 | 1238838 | 2239808 |

| | 10. labor | 11. property | 12. enterprise | 13. household | 14. government | 15. capaccount | 16. row | 17. rowtaxes | 18. error |
|----------------|-----------|--------------|----------------|---------------|----------------|----------------|---------|--------------|-----------|
| 1. agforsh | 0 | 0 | 0 | 17573 | 6940 | 659 | 21562 | 0 | 0 |
| 2. mining | 0 | 0 | 0 | 877 | 473 | 1600 | 8132 | 0 | 0 |
| 3. construct | 0 | 0 | 0 | 0 | 133789 | 357941 | 160 | 0 | 0 |
| 4. ndurmfg | 0 | 0 | 0 | 452646 | 38311 | 3511 | 93137 | 0 | 0 |
| 5. durmfg | 0 | 0 | 0 | 236374 | 96719 | 295724 | 187098 | 0 | 0 |
| 6. trcomut | 0 | 0 | 0 | 310041 | 33654 | 12788 | 25938 | 0 | 0 |
| 7. trade | 0 | 0 | 0 | 528885 | 11051 | 55747 | 42668 | 0 | 0 |
| 8. fininsre | 0 | 0 | 0 | 771344 | 15741 | 22287 | 24832 | 0 | 0 |
| 9. services | 0 | 0 | 0 | 917354 | 632269 | 0 | 27391 | 0 | 0 |
| 10. labor | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11. property | 0 | 0 | 0 | 0 | 0 | 0 | 116747 | 0 | 0 |
| 12. enterprise | 0 | 1589072 | 0 | 96146 | 92292 | 0 | 0 | 0 | 0 |
| 13. household | 2463048 | 0 | 1045732 | 0 | 555683 | 0 | 0 | 0 | 0 |
| 14. government | 444599 | 0 | 137936 | 586649 | 0 | 96146 | 0 | 16448 | 0 |
| 15. capaccount | 0 | 0 | 593842 | 144711 | 0 | 0 | 117450 | 0 | -9600 |
| 16. row | 0 | 83431 | 0 | 1862 | 41922 | 0 | 0 | 0 | 0 |
| 17. rowtaxes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18. error | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19. total | 2907647 | 1672503 | 1777510 | 4064462 | 1658844 | 846403 | 665115 | 16448 | -9600 |

CHAPTER 4

THE MODEL IN ACTION

This final chapter addresses the actual use of the ITC CGE model for commercial policy analysis. To focus the discussion, a specific sector is chosen for consideration, ITC sector 352, electric lamps. Examination of the fully disaggregated ITC social accounting matrix reveals that there are three important upstream sectors supplying the electric lamps sector. These are: sector 221, glass and glass products, except containers; sector 264, nonferrous wire drawing and insulating; and sector 366, electrical equipment and suppliers, n.e.c.. These three upstream sectors plus the electric lamps sector itself form the four focus sectors of the project. These and the nine standard reference sectors are presented in table 2.

Aggregation of the ITC SAM to the 13 sectors of table 2 produces the project specific SAM presented in Table 3. The SAM consists of 22 accounts. Accounts 1-13 are the sectoral accounts corresponding to the 13 sectors of table 2. Accounts 14-22 are the institutional accounts. Expenditures are listed down the columns of the table, and receipts are listed across the rows. For example, entry (20,1) gives imports of lamps as a payment by the lamp sector to the rest of the world (row). Entry (3,1) gives intermediate inputs of wire into lamp production as a payment by the lamp sector to the wire sector. All the figures in table 3 are used to calibrate a model to analyze the electric lamps sector.

The electric lamps sector has a tariff rate of approximately 3 percent. One potential experiment that might be of interest to the Commission analyst is the doubling of this tariff rate to 6 percent. This experiment is simulated with the ITC CGE model with labor supply and nominal government spending fixed. The doubling of the tariff raises costs of this item to

households. As a result of this and other adjustments in the economy, the welfare of the United States falls by \$8 million.¹ Since imports of lamps fall, the exchange rate appreciates by a small amount, lowering the prices of other traded goods and returning the trade balance back to its original position.

Perhaps the most interesting results provided by the CGE model are at the sectoral level. For the tariff increase experiment, the sectoral results are presented in table 4. As a protective measure, the doubling of the tariff succeeds in reducing lamp imports by 191 basis points (nearly 2 percent). The reduced import competition allows domestic output to expand by 26 basis points and employment to increase by 44 full-time equivalent (FTE) jobs. Exports also expand by approximately 25 basis points. As the lamp sector expands, it demands more intermediate inputs from the three upstream supplier sectors. Some of this increased demand is met by increased domestic output, and the rest is met by increased imports.

Outputs of the reference sectors change by less than one-tenth of a basis point in each case. The slight changes in employment in these sectors, however, allow us to identify the direction of the output change. Employment levels in the construction and services sectors rise, while those for the other reference sectors fall. Due to the appreciation of the exchange rate, imports in the reference sectors rise slightly, while exports fall slightly. These are the sort of economy-wide effects that one cannot account for with a single sector model.

⁹ Welfare is measured in the ITC CGE model using the concept of equivalent variation. The equivalent variation measure asks what income change at the base year prices would need to be given to or taken away from households so that they are as well off as under the alternative policy scenario.

Table 2
Focus and reference sectors

| Sector | Label | Title |
|---------------------------|-----------|---|
| Focus sectors: | | |
| 1 | Lamps | Electric Lamps |
| 2 | Glass | Glass and Glass Products, Except Containers |
| 3 | Wire | Nonferrous Wire Drawing and Insulating |
| 4 | Electric | Electrical Equipment and Supplies, n.e.c. |
| Reference sectors: | | |
| 5 | Agforish | Agriculture, Forestry, and Fishing |
| 6 | Mining | Mining and Mineral Resources |
| 7 | Construct | Construction |
| 8 | Ndurmfng | Nondurable Manufacturing |
| 9 | Durmfng | Durable Manufacturing |
| 10 | Trcomut | Transportation, Communication, Utilities |
| 11 | Trade | Wholesale and Retail Trade |
| 12 | Fininsre | Finance, Insurance, and Real Estate |
| 13 | Services | Personal, Business, and Public Services |

Table 3
Estimated social accounting matrix for lamp tariff exercise

(Millions of dollars)

| | 1 lamp | 2 glass | 3 wire | 4 electric | 5 agforfsh | 6 mining | 7 construct | 8 ndurmfg | 9 durmfg | 10 trcomut | 11 trade | 12 fininsre | 13 services |
|---------------|-----------|------------|-----------|---------------|---------------|-------------|----------------|--------------|-------------|---------------|-------------|----------------|----------------|
| 1 lamp | 1 | 1 | 5 | 17 | 14 | 1 | 82 | 74 | 342 | 353 | 106 | 141 | 538 |
| 2 glass | 287 | 1079 | 23 | 2 | 7 | 4 | 598 | 884 | 3892 | 49 | 57 | 38 | 1516 |
| 3 wire | 129 | 1 | 1182 | 140 | 0 | 30 | 7226 | 30 | 4997 | 146 | 0 | 0 | 50 |
| 4 electric | 509 | 0 | 13 | 53 | 21 | 13 | 514 | 26 | 558 | 0 | 0 | 0 | 0 |
| 5 agforfsh | 0 | 1 | 0 | 0 | 42174 | 7 | 2408 | 98260 | 7782 | 74 | 2683 | 7610 | 6565 |
| 6 mining | 0 | 78 | 1 | 1 | 68 | 9626 | 2244 | 81959 | 8012 | 34823 | 1 | 25 | 25 |
| 7 construct | 13 | 73 | 60 | 9 | 1806 | 11668 | 625 | 6767 | 8593 | 20927 | 5527 | 35989 | 17626 |
| 8 ndurmfg | 146 | 719 | 1496 | 110 | 29973 | 1015 | 34995 | 370421 | 80805 | 37101 | 24004 | 14290 | 149157 |
| 9 durmfg | 61 | 694 | 5390 | 400 | 4031 | 2546 | 166492 | 53646 | 459765 | 18268 | 7331 | 4216 | 78872 |
| 10 trcomut | 118 | 964 | 584 | 118 | 4511 | 1240 | 16564 | 66440 | 62973 | 78291 | 45619 | 30976 | 83618 |
| 11 trade | 232 | 412 | 720 | 113 | 8202 | 753 | 72451 | 57265 | 71505 | 10949 | 13764 | 7129 | 49736 |
| 12 fininsre | 62 | 204 | 192 | 49 | 10083 | 2667 | 9646 | 17949 | 24703 | 14466 | 51925 | 193663 | 79024 |
| 13 services | 167 | 487 | 488 | 121 | 4989 | 1410 | 52562 | 68116 | 73095 | 30890 | 123868 | 93098 | 213502 |
| 14 labor | 626 | 3722 | 2975 | 757 | 32505 | 18242 | 197013 | 218389 | 421800 | 211905 | 384751 | 217417 | 1197545 |
| 15 property | 709 | 791 | 588 | 91 | 60036 | 55682 | 31662 | 141784 | 66725 | 207225 | 146709 | 511312 | 332442 |
| 16 enterprise | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 household | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 government | 17 | 187 | 206 | 23 | 7755 | 11736 | 7014 | 27723 | 17857 | 35207 | 126693 | 113027 | 29621 |
| 19 capaccount | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 row | 527 | 1660 | 521 | 1326 | 8167 | 31302 | 0 | 114621 | 290925 | 74768 | 0 | 11769 | 2315 |
| 21 rowtaxes | 15 | 125 | 14 | 47 | 176 | 192 | 0 | 8341 | 7537 | 0 | 0 | 0 | 0 |
| 22 error | -3 | -10 | -8 | -2 | -222 | -189 | -521 | -858 | -1120 | -1005 | -1456 | -1862 | -2344 |

Table 3—Continued
Estimated social accounting matrix for lamp tariff exercise

(Millions of dollars)

| | 14 labor | 15 property | 16 enterprise | 17 household | 18 government | 19 capaccount | 20 row | 21 rowtaxes | 22 error |
|---------------|-------------|----------------|------------------|-----------------|------------------|------------------|-----------|----------------|-------------|
| 1 lamp | 0 | 0 | 0 | 1492 | 274 | 0 | 179 | 0 | 0 |
| 2 glass | 0 | 0 | 0 | 1465 | 376 | 0 | 911 | 0 | 0 |
| 3 wire | 0 | 0 | 0 | 12 | 44 | 119 | 343 | 0 | 0 |
| 4 electric | 0 | 0 | 0 | 789 | 48 | 22 | 808 | 0 | 0 |
| 5 agfortsh | 0 | 0 | 0 | 17573 | 6940 | 659 | 21562 | 0 | 0 |
| 6 mining | 0 | 0 | 0 | 877 | 473 | 1600 | 8132 | 0 | 0 |
| 7 construct | 0 | 0 | 0 | 0 | 133789 | 357941 | 160 | 0 | 0 |
| 8 ndurmfg | 0 | 0 | 0 | 452646 | 38311 | 3511 | 93137 | 0 | 0 |
| 9 durmfg | 0 | 0 | 0 | 232616 | 95977 | 295583 | 184858 | 0 | 0 |
| 10 trcomut | 0 | 0 | 0 | 310041 | 33654 | 12788 | 25938 | 0 | 0 |
| 11 trade | 0 | 0 | 0 | 528885 | 11051 | 55747 | 42668 | 0 | 0 |
| 12 fininsre | 0 | 0 | 0 | 771344 | 15741 | 22287 | 24832 | 0 | 0 |
| 13 services | 0 | 0 | 0 | 917354 | 632269 | 0 | 27391 | 0 | 0 |
| 14 labor | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 property | 0 | 0 | 0 | 0 | 0 | 0 | 116747 | 0 | 0 |
| 16 enterprise | 0 | 1589072 | 0 | 96146 | 92292 | 0 | 0 | 0 | 0 |
| 17 household | 2463048 | 0 | 1045732 | 0 | 555683 | 0 | 0 | 0 | 0 |
| 18 government | 444599 | 0 | 137936 | 586649 | 0 | 96146 | 0 | 16448 | 0 |
| 19 capaccount | 0 | 0 | 593842 | 144711 | 0 | 0 | 117450 | 0 | -9600 |
| 20 row | 0 | 83431 | 0 | 1862 | 41922 | 0 | 0 | 0 | 0 |
| 21 rowtaxes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 error | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Key: row= rest of world
rowtaxes= rest of world taxes or tariffs
capaccount = capital account

Table 4**Sectoral results of the tariff experiment (change from base year in basis points, except where indicated)**

| <i>Sector</i> | <i>Output</i> | <i>Employment^a</i> | <i>Imports</i> | <i>Exports</i> |
|---------------|---------------|-------------------------------|----------------|----------------|
| 1 Lamps | 26.3 | 44 | -191.2 | 24.8 |
| 2 Glass | 0.8 | 10 | 0.8 | 0.8 |
| 3 Wire | 0.3 | 0 | 0.3 | 0.2 |
| 4 Electric | 4.7 | 7 | 5.5 | 4.5 |
| 5 Agforfsh | 0.0 | -12 | 0.0 | -0.4 |
| 6 Mining | 0.0 | -3 | 0.0 | -0.2 |
| 7 Construct | 0.0 | 8 | 0.0 | |
| 8 Ndurmfg | 0.0 | -18 | 0.0 | 0.0 |
| 9 Durmfg | 0.0 | -57 | 0.1 | -0.1 |
| 10 Trcomut | 0.0 | -13 | 0.1 | -0.2 |
| 11 Trade | 0.0 | -23 | -0.2 | |
| 12 Fininsre | 0.0 | -10 | 0.1 | -0.2 |
| 13 Services | 0.0 | 68 | 0.1 | -0.1 |

^a Full-time equivalent (FTE) employees.

Note.—A basis point is one one-hundredth of a percent.

APPENDIX A

MODEL FORMULATION

APPENDIX A MODEL FORMULATION

This appendix presents the current specification of the ITC CGE model in a more technical fashion than in chapter 3. The specification of the model is divided into eight components: final demand behavior, production technology, factor supplies and demands, treatment of traded goods, domestic prices, domestic market equilibrium, the foreign sector, and income and government revenue. For simplicity of exposition, a one-sector version of the model is considered. However, even the one-sector model contains more than one good. The model views each sector as consisting of *three* goods, where imports and exports in each sector are imperfect substitutes for their domestic counterparts. Imports combine with the domestic substitute to form a composite good, and domestic output is supplied to both the domestic market and the export market.

Final Demand Behavior

The ITC CGE model considers three separate components of domestic final demand: household consumption, government demand, and investment demand. The consumption behavior of households is given in equation 1:

$$c = \text{LES}(p_q, (1-s^*)Y; \eta) \quad (1)$$

where c denotes real personal consumption, p_q denotes the domestic price of the composite good, s^* is the fixed savings rate, Y is domestic income, and η is the income elasticity of demand. The functional form is that of the linear expenditure system (LES).¹⁰ The LES is a generalization of the Cobb-Douglas utility function in which the origin is translated to a point in the positive quadrant. While the income expansion paths are linear, the displaced origin allows preferences to be nonhomothetic.

¹⁰ For an introduction to the LES, see ch. 5 of Layard and Walters (1978), ch. 3 of Deaton and Muellbauer (1980), app. A.5 of Dervis, de Melo, and Robinson (1982), and ch. 11 of Silberberg (1990).

That is, income elasticities of demand can differ from unity. This is an important feature of the model.

The specification of government demand can take two forms. In the first, we fix nominal government spending as follows:

$$p_q g = G^* \quad (2a)$$

where g is real government demand and G^* is exogenously specified, nominal government spending.

In the second, we fix real government spending:

$$g = g^* \quad (2b)$$

where g^* is the exogenously specified, real government spending.

For investment demand, we assume that real investment is held constant as in:

$$i = i^* \quad (3)$$

where i is real investment and i^* is its exogenously-specified level. This specification avoids questions concerning the substitution between present and future consumption which would make static welfare comparisons difficult.

Production Technology

Production technology is modeled using a constant elasticity of substitution (CES) value added function specified as:¹¹

$$x = \text{CES}(l_d, k_d; \phi) \quad (4)$$

where x denotes gross domestic output, l_d is labor demand, k_d is capital demand, and ϕ is the elasticity of substitution between labor and capital. The parameter ϕ is exogenous and is estimated outside of the model. A Leontief (fixed coefficients) function is assumed between value added and intermediate products as well as between various intermediates. Intermediate use is given by:

¹¹ For an introduction to CES production functions, see ch. 9 of Layard and Walters (1978) and ch. 9 of Silberberg (1990).

$$v = a x \quad (5)$$

where v is total intermediate use and a is the intermediate use coefficient. The coefficient a is determined by calibration to the social accounting matrix.

Factor Supplies and Demands

As generally is the case in CGE models, the factors of production, labor and capital, are often assumed to be in fixed supply. This assumption is specified in the following two equations:

$$l_s = l^* \quad (6a)$$

$$k_s = k^* \quad (7)$$

where l_s is the labor supply set equal to the exogenous level l^* and k_s is capital supply set equal to the exogenous level k^* .

Alternatively, however, we can specify a labor supply function using a linear expenditure system as in de Melo and Tarr (forthcoming):

$$l_s = \text{LES}(w, p_q, (1-s^*)Y; \epsilon) \quad (6b)$$

where w is the wage and ϵ is the elasticity of labor supply.

Factor demands are derived from the CES production function and specify labor-capital shares which depend on relative factor prices and the elasticity of substitution as in:

$$l_d/k_d = \text{CES}(r, w; \phi) \quad (8)$$

where r is the rental rate on capital.

Treatment of Traded Goods

The treatment of traded goods is the most important component of the model specification. As mentioned in the introduction to this section, the model

views each sector as consisting of three good, where imports and exports in each industry category are imperfect substitutes for their domestic counterparts.¹² On the import side, the model treats foreign and domestic commodities as imperfect substitutes in domestic use. Therefore, the import composition of domestic demand is influenced by the ratio of domestic and import prices, as well as by any administrative quantity restrictions. The model aggregates imports and their domestic counterparts into an aggregate good q using a CES aggregation:

$$q = \text{CES}(d_d, m; \sigma) \quad (9)$$

$$d_d/m = \text{CES}(p_d, p_m; \sigma) \quad (10)$$

Equation 9 is the aggregation relation in which q denotes the composite good for domestic consumption, d_d denotes domestic demand for domestic goods, m denotes imports, and σ is the elasticity of substitution between imports and domestic goods within the sector.¹³ Equation 10 is the tangency condition in which p_d is the price of domestic goods and p_m is the domestic price of imports.

The use of the CES functional form for aggregation implies that preferences with respect to imports and domestic goods within a sector are homothetic, while preferences between sectors are not. For a given level of demand for a product category, determined by the specification of the three components of final demand, the shares of imports and domestic goods are determined in response to relative prices.

On the export side, the model assumes that domestic firms allocate their output between domestic and foreign markets according to a transformation function which depends on the ratio of domestic and foreign prices. Therefore, the export composition of domestic supply is influenced by the ratio of domestic and export prices. The functional form used is a

¹² The treatment of traded goods follows de Melo and Robinson (1989).

¹³ This is often referred to as the "Armington" elasticity (Armington 1969).

constant elasticity of transformation (CET) as indicated in the following equations:²

$$x = \text{CET}(d_s, e; \tau) \quad (11)$$

$$d_s/e = \text{CET}(p_d, p_e; \tau) \quad (12)$$

Equation 11 is the allocation relation in which d_s is domestic supply, e is exports, and τ is the elasticity of transformation between domestic supply and exports. Equation 12 is the tangency condition in which p_e is the domestic price of exports. The shares of domestic supply and exports are determined in response to relative prices.

Domestic Prices

We next turn to the equations for domestic prices, including those of import and export goods. These are given in the following five equations:

$$p_x x = p_d d_s + p_e e \quad (13)$$

$$p_q q = p_d d_s + p_m m \quad (14)$$

$$p_m = (1 + t_m)(1 + \rho_m) n \pi_m \quad (15)$$

$$p_e = n \pi_e \quad (16)$$

where t_m is the tariff rate, ρ_m is the quota premium rate, π_m is the world price of the import good, π_e is the world price of the export good, and n is the exchange rate (U.S. dollars per unit of foreign currency).

¹⁴ The original reference to this functional form is Powell and Gruen (1968).

Domestic Market Equilibrium

Three equations are required for domestic market equilibrium, one for the commodity market and two others for the factor markets:

$$q = v + c + i + g \quad (17)$$

$$l_s = l_d \quad (18)$$

$$k_s = k_d \quad (19)$$

The Foreign Sector

We next need to characterize the foreign sector. We do so with the following three equations:

$$B^* = \pi_m m - \pi_e e \quad (20)$$

$$m = s_m(\pi_m; \sigma_f) \quad (21)$$

$$e = d_e(\pi_e; \tau_f) \quad (22)$$

where B^* is the exogenously-specified balance of payments or foreign saving, σ_f is the elasticity of import supply, and τ_f is the elasticity of export demand.

Income and Government Revenue

The national income identity is given as follows:

$$Y = w l_d + r k_d + n t_m m + n B^* \quad (23)$$

The income of the representative consumer includes wages, rental income, government revenue, plus foreign savings.

In the actual computer code of the model, private households, enterprises, and government are disaggregated into separate income and expenditure specifications, and a wider variety of fiscal instruments (e.g. income taxes and indirect business taxes) is included.

APPENDIX B
ITC CGE DATABASE SECTORS

APPENDIX B

ITC CGE DATABASE SECTORS

| <i>Sector</i> | <i>BEA Sector^a</i> | <i>Description</i> |
|---------------|-----------------------------------|--|
| 1 | 010100 | Dairy farm products |
| 2 | 010200 | Poultry and eggs |
| 3 | 010301 | Meat animals |
| 4 | 010302 | Miscellaneous livestock |
| 5 | 020100 | Cotton |
| 6 | 020201 | Food grains |
| 7 | 020202 | Feed grains |
| 8 | 020203 | Grass seeds |
| 9 | 020300 | Tobacco |
| 10 | 020401 | Fruits |
| 11 | 020402 | Tree nuts |
| 12 | 020501 | Vegetables |
| 13 | 020502 | Sugar crops |
| 14 | 020503 | Miscellaneous crops |
| 15 | 020600 | Oil bearing crops |
| 16 | 020701 | Forest products |
| 17 | 020702 | Greenhouse and nursery products |
| 18 | 030001 | Forestry products |
| 19 | 030002 | Commercial fishing |
| 20 | 040001 | Agricultural, forestry, and fishery services |
| 21 | 040002 | Landscape and horticultural services |
| 22 | 050000 | Iron and ferroalloy ores mining |
| 23 | 060100 | Copper and ore mining |
| 24 | 060200 | Nonferrous metal ores mining, except copper |
| 25 | 070000 | Coal mining |
| 26 | 080000 | Crude petroleum and natural gas |
| 27 | 090001 | Dimension, crushed and broken stone mining and quarrying |
| 28 | 090002 | Sand and gravel mining |
| 29 | 090003 | Clay, ceramic, and refractory minerals mining |
| 30 | 090004 | Nonmetallic mineral services and miscellaneous minerals mining |
| 31 | 100000 | Chemical and fertilizer mineral mining |
| 32 | 110100 | New residential structures |
| 33 | 110200 | New industrial and commercial buildings |
| 34 | 110300 | New utility structures |
| 35 | 110400 | New highways and streets |
| 36 | 110500 | New farm structures |
| 37 | 110600 | New mineral extraction facilities |
| 38 | 110700 | New government facilities |
| 39 | 120100 | Maintenance and repair, residential |
| 40 | 120200 | Maintenance and repair, other facilities |
| 41 | 120215 | Maintenance and repair, oil and gas wells |
| 42 | 130100 | Guided missiles and space vehicles |
| 43 | 130200 | Ammunition, except for small arms, n.e.c. |
| 44 | 130300 | Tank and tank components |
| 45 | 130500 | Small arms |
| 46 | 130600 | Small arms ammunition |
| 47 | 130700 | Other ordnance and accessories |
| 48 | 140101 | Meat packing plants |
| 49 | 140102 | Sausages and other prepared meats |
| 50 | 140103 | Poultry dressing plants |

ITC CGE DATABASE SECTORS—Continued

| <i>Sector</i> | <i>BEA Sector^a</i> | <i>Description</i> |
|---------------|-----------------------------------|--|
| 51 | 140104 | Poultry and egg processing |
| 52 | 140200 | Creamery butter |
| 53 | 140300 | Cheese, natural and processed |
| 54 | 140400 | Condensed and evaporated milk |
| 55 | 140500 | Ice cream and frozen deserts |
| 56 | 140600 | Fluid milk |
| 57 | 140700 | Canned and cured sea foods |
| 58 | 140800 | Canned specialties |
| 59 | 140900 | Canned fruits and vegetables |
| 60 | 141000 | Dehydrated food products |
| 61 | 141100 | Pickles, sauces, and salad dressings |
| 62 | 141200 | Fresh or frozen packaged fish |
| 63 | 141301 | Frozen fruits, fruit juices and vegetables |
| 64 | 141302 | Frozen specialties |
| 65 | 141401 | Flour and other grain mill products |
| 66 | 141402 | Cereal breakfast foods |
| 67 | 141403 | Blended and prepared flour |
| 68 | 141501 | Dog, cat, and other pet food |
| 69 | 141502 | Prepared feeds, n.e.c. |
| 70 | 141600 | Rice milling |
| 71 | 141700 | Wet corn milling |
| 72 | 141801 | Bread, cake, and related products |
| 73 | 141802 | Cookies and crackers |
| 74 | 141900 | Sugar |
| 75 | 142001 | Confectionery products |
| 76 | 142002 | Chocolate and cocoa products |
| 77 | 142003 | Chewing gum |
| 78 | 142101 | Malt beverages |
| 79 | 142102 | Malt |
| 80 | 142103 | Wine, brandy, and brandy spirits |
| 81 | 142104 | Distilled liquor, except brandy |
| 82 | 142200 | Bottled and canned soft drinks |
| 83 | 142300 | Flavoring extracts and syrups, n.e.c. |
| 84 | 142400 | Cottonseed oil mills |
| 85 | 142500 | Soybean oil mills |
| 86 | 142600 | Vegetable oil mills, n.e.c. |
| 87 | 142700 | Animal and marine fats and oils |
| 88 | 142800 | Roasted coffee |
| 89 | 142900 | Shortening and cooking oils |
| 90 | 143000 | Manufactured ice |
| 91 | 143100 | Macaroni and spaghetti |
| 92 | 143200 | Food preparations, n.e.c. |
| 93 | 150101 | Cigarettes |
| 94 | 150102 | Cigars |
| 95 | 150103 | Chewing and smoking tobacco |
| 96 | 150200 | Tobacco stemming and redrying |
| 97 | 160100 | Broadwoven fabric mills and finishing |
| 98 | 160200 | Narrow fabric mills |
| 99 | 160300 | Yarn mills and finishing of textiles, n.e.c. |
| 100 | 160400 | Thread mills |

ITC CGE DATABASE SECTORS—Continued

| <i>Sector</i> | <i>BEA Sector^a</i> | <i>Description</i> |
|---------------|-----------------------------------|---------------------------------------|
| 101 | 170100 | Floor coverings |
| 102 | 170200 | Felt goods, n.e.c. |
| 103 | 170300 | Lace goods |
| 104 | 170400 | Padding and upholstery filling |
| 105 | 170500 | Processed textile waste |
| 106 | 170600 | Coated fabrics, not rubberized |
| 107 | 170700 | Tire cord and fabric |
| 108 | 170900 | Cordage and twine |
| 109 | 171001 | Nonwoven fabrics |
| 110 | 171002 | Textile goods, n.e.c. |
| 111 | 180101 | Women's hosiery, except socks |
| 112 | 180102 | Hosiery, n.e.c. |
| 113 | 180201 | Knit outerwear mills |
| 114 | 180202 | Knit underwear mills |
| 115 | 180203 | Knitting mills, n.e.c. |
| 116 | 180300 | Knit fabric mills |
| 117 | 180400 | Apparel made from purchased materials |
| 118 | 190100 | Curtains and draperies |
| 119 | 190200 | Housefurnishings, n.e.c. |
| 120 | 190301 | Textile bags |
| 121 | 190302 | Canvas and related products |
| 122 | 190303 | Pleating and stitching |
| 123 | 190304 | Automotive and apparel trimmings |
| 124 | 190305 | Schiffli machine embroideries |
| 125 | 190306 | Fabricated textile products, n.e.c. |
| 126 | 200100 | Logging camps and logging contractors |
| 127 | 200200 | Sawmills and planing mills, general |
| 128 | 200300 | Hardwood dimension and flooring mills |
| 129 | 200400 | Special product sawmills, n.e.c. |
| 130 | 200501 | Millwork |
| 131 | 200502 | Wood kitchens and cabinets |
| 132 | 200600 | Veneer and plywood |
| 133 | 200701 | Structural wood members, n.e.c. |
| 134 | 200702 | Prefabricated wood buildings |
| 135 | 200800 | Wood preserving |
| 136 | 200901 | Wood pallets and skids |
| 137 | 200902 | Particleboard |
| 138 | 200903 | Wood products, n.e.c. |
| 139 | 210000 | Wood containers |
| 140 | 220101 | Wood household furniture |
| 141 | 220102 | Household furniture, n.e.c. |
| 142 | 220103 | Wooden TV and radio cabinets |
| 143 | 220200 | Upholstered household furniture |
| 144 | 220300 | Metal household furniture |
| 145 | 220400 | Mattresses and bedsprings |
| 146 | 230100 | Wood office furniture |
| 147 | 230200 | Metal office furniture |
| 148 | 230300 | Public building furniture |
| 149 | 230400 | Wood partitions and fixtures |
| 150 | 230500 | Metal partitions and fixtures |

ITC CGE DATABASE SECTORS—Continued

| <i>Sector</i> | <i>BEA Sector^a</i> | <i>Description</i> |
|---------------|-----------------------------------|--|
| 151 | 230600 | Drapery hardware and blinds and shades |
| 152 | 230700 | Furniture and fixtures, n.e.c. |
| 153 | 240100 | Pulp mills |
| 154 | 240200 | Paper mills, except building papers |
| 155 | 240300 | Paperboard mills |
| 156 | 240400 | Envelopes |
| 157 | 240500 | Sanitary paper products |
| 158 | 240602 | Building paper and board mills |
| 159 | 240701 | Paper coating and glazing |
| 160 | 240702 | Bags, except textile |
| 161 | 240703 | Die-cut paper and board |
| 162 | 240704 | Pressed and molded pulp goods |
| 163 | 240705 | Stationary products |
| 164 | 240706 | Converted paper products, n.e.c. |
| 165 | 250000 | Paperboard containers and boxes |
| 166 | 260100 | Newspapers |
| 167 | 260200 | Periodicals |
| 168 | 260301 | Book publishing |
| 169 | 260302 | Book printing |
| 170 | 260400 | Miscellaneous publishing |
| 171 | 260501 | Commercial printing |
| 172 | 260502 | Lithographic platemaking and services |
| 173 | 260601 | Manifold business forms |
| 174 | 260602 | Blankbooks and looseleaf binders |
| 175 | 260700 | Greeting card publishing |
| 176 | 260801 | Engraving and plate printing |
| 177 | 260802 | Bookbinding and related work |
| 178 | 260803 | Typesetting |
| 179 | 260804 | Photoengraving |
| 180 | 260805 | Electrotyping and stereotyping |
| 181 | 270100 | Industrial inorganic and organic chemicals |
| 182 | 270201 | Nitrogenous and phosphatic fertilizers |
| 183 | 270202 | Fertilizers, mixing only |
| 184 | 270300 | Agricultural chemicals, n.e.c. |
| 185 | 270401 | Gum and wood chemicals |
| 186 | 270402 | Adhesives and sealants |
| 187 | 270403 | Explosives |
| 188 | 270404 | Printing ink |
| 189 | 270405 | Carbon black |
| 190 | 270406 | Chemical preparations, n.e.c. |
| 191 | 280100 | Plastics materials and resins |
| 192 | 280200 | Synthetic rubber |
| 193 | 280300 | Cellulosic man-made fibers |
| 194 | 280400 | Organic fibers, noncellulosic |
| 195 | 290100 | Drugs |
| 196 | 290201 | Soap and other detergents |
| 197 | 290202 | Polishes and sanitation goods |
| 198 | 290203 | Surface active agents |
| 199 | 290300 | Toilet preparations |
| 200 | 300000 | Paints and allied products |

ITC CGE DATABASE SECTORS—Continued

| <i>Sector</i> | <i>BEA Sector^a</i> | <i>Description</i> |
|---------------|-----------------------------------|---|
| 201 | 310101 | Petroleum refining |
| 202 | 310102 | Lubricating oils and greases |
| 203 | 310103 | Products of petroleum and coal, n.e.c. |
| 204 | 310200 | Paving mixtures and blocks |
| 205 | 310300 | Asphalt felts and coatings |
| 206 | 320100 | Tires and inner tubes |
| 207 | 320200 | Rubber and plastics footwear |
| 208 | 320301 | Reclaimed rubber |
| 209 | 320302 | Fabricated rubber products, n.e.c. |
| 210 | 320400 | Miscellaneous plastics products |
| 211 | 320500 | Rubber and plastics hose and belting |
| 212 | 330001 | Leather tanning and finishing |
| 213 | 340100 | Boot and shoe cut stock and findings |
| 214 | 340201 | Shoes, except rubber |
| 215 | 340202 | House slippers |
| 216 | 340301 | Leather gloves and mittens |
| 217 | 340302 | Luggage |
| 218 | 340303 | Women's handbags and purses |
| 219 | 340304 | Personal leather goods |
| 220 | 340305 | Leather goods, n.e.c. |
| 221 | 350100 | Glass and glass products, except containers |
| 222 | 350200 | Glass containers |
| 223 | 360100 | Cement, hydraulic |
| 224 | 360200 | Brick and structural clay tile |
| 225 | 360300 | Ceramic wall and floor tile |
| 226 | 360400 | Clay refractories |
| 227 | 360500 | Structural clay products, n.e.c. |
| 228 | 360600 | Vitreous plumbing fixtures |
| 229 | 360701 | Vitreous china food utensils |
| 230 | 360702 | Fine earthenware food utensils |
| 231 | 360800 | Porcelain electrical supplies |
| 232 | 360900 | Pottery products, n.e.c. |
| 233 | 361000 | Concrete block and brick |
| 234 | 361100 | Concrete products, n.e.c. |
| 235 | 361200 | Ready-mixed concrete |
| 236 | 361300 | Lime |
| 237 | 361400 | Gypsum products |
| 238 | 361500 | Cut stone and stone products |
| 239 | 361600 | Abrasive products |
| 240 | 361700 | Asbestos products |
| 241 | 361800 | Gaskets, packing and sealing devices |
| 242 | 361900 | Mineral, ground or treated |
| 243 | 362000 | Mineral wool |
| 244 | 362100 | Nonclay refractories |
| 245 | 362200 | Nonmetallic mineral products, n.e.c. |
| 246 | 370101 | Blast furnaces and steel mills |
| 247 | 370102 | Electrometallurgical products |
| 248 | 370103 | Steel wire and related products |
| 249 | 370104 | Cold finishing of steel shapes |
| 250 | 370105 | Steel pipe and tubes |

ITC CGE DATABASE SECTORS—Continued

| <i>Sector</i> | <i>BEA Sector^a</i> | <i>Description</i> |
|---------------|-----------------------------------|--|
| 251 | 370200 | Iron and steel foundries |
| 252 | 370300 | Iron and steel forgings |
| 253 | 370401 | Metal heat treating |
| 254 | 370402 | Primary metal products, n.e.c. |
| 255 | 380100 | Primary copper |
| 256 | 380200 | Primary lead |
| 257 | 380300 | Primary zinc |
| 258 | 380400 | Primary aluminum |
| 259 | 380500 | Primary nonferrous metals, n.e.c. |
| 260 | 380600 | Secondary nonferrous metals |
| 261 | 380700 | Copper rolling and drawing |
| 262 | 380800 | Aluminum rolling and drawing |
| 263 | 380900 | Nonferrous rolling and drawing, n.e.c. |
| 264 | 381000 | Nonferrous wire drawing and insulating |
| 265 | 381100 | Aluminum castings |
| 266 | 381200 | Brass, bronze, and copper castings |
| 267 | 381300 | Nonferrous castings, n.e.c. |
| 268 | 381400 | Nonferrous forgings |
| 269 | 390100 | Metal cans |
| 270 | 390200 | Metal barrels, drums and pails |
| 271 | 400100 | Metal sanitary ware |
| 272 | 400200 | Plumbing fixture fittings and trim |
| 273 | 400300 | Heating equipment, except electric |
| 274 | 400400 | Fabricated structural metal |
| 275 | 400500 | Metal doors, sash, and trim |
| 276 | 400600 | Fabricated plate work (boiler shops) |
| 277 | 400700 | Sheet metal work |
| 278 | 400800 | Architectural metal work |
| 279 | 400901 | Fabricated metal buildings |
| 280 | 400902 | Miscellaneous metal work |
| 281 | 410100 | Screw machine products and bolts, etc. |
| 282 | 410201 | Automotive stampings |
| 283 | 410202 | Crowns and closures |
| 284 | 410203 | Metal stampings, n.e.c. |
| 285 | 420100 | Cutlery |
| 286 | 420201 | Hand and edge tools, n.e.c. |
| 287 | 420202 | Hand saws and saw blades |
| 288 | 420300 | Hardware, n.e.c. |
| 289 | 420401 | Plating and polishing |
| 290 | 420402 | Metal coating and allied services |
| 291 | 420500 | Miscellaneous fabricated wire products |
| 292 | 420700 | Steel springs, except wire |
| 293 | 420800 | Pipe, valves, and pipe fittings |
| 294 | 421000 | Metal foil and leaf |
| 295 | 421100 | Fabricated metal products, n.e.c. |
| 296 | 430100 | Turbines and turbine generator sets |
| 297 | 430200 | Internal combustion engines, n.e.c. |
| 298 | 440001 | Farm machinery and equipment |
| 299 | 440002 | Lawn and garden equipment |
| 300 | 450100 | Construction machinery and equipment |

ITC CGE DATABASE SECTORS—Continued

| <i>Sector</i> | <i>BEA Sector^a</i> | <i>Description</i> |
|---------------|-----------------------------------|---|
| 301 | 450200 | Mining machinery, except oil field |
| 302 | 450300 | Oil field machinery |
| 303 | 460100 | Elevators and moving stairways |
| 304 | 460200 | Conveyors and conveying equipment |
| 305 | 460300 | Hoists, cranes, and monorails |
| 306 | 460400 | Industrial trucks and tractors |
| 307 | 470100 | Machine tools, metal cutting types |
| 308 | 470200 | Machine tools, metal forming types |
| 309 | 470300 | Special dies and tools and machine tool access. |
| 310 | 470401 | Power driven hand tools |
| 311 | 470402 | Rolling mill machinery |
| 312 | 470403 | Metalworking machinery, n.e.c. |
| 313 | 480100 | Food products machinery |
| 314 | 480200 | Textile machinery |
| 315 | 480300 | Woodworking machinery |
| 316 | 480400 | Paper industries machinery |
| 317 | 480500 | Printing trades machinery |
| 318 | 480600 | Special industry machinery, n.e.c. |
| 319 | 490100 | Pumps and compressors |
| 320 | 490200 | Ball and roller bearings |
| 321 | 490300 | Blowers and fans |
| 322 | 490400 | Industrial patterns |
| 323 | 490500 | Power transmission equipment |
| 324 | 490600 | Industrial furnaces and ovens |
| 325 | 490700 | General industrial machinery, n.e.c. |
| 326 | 500001 | Carburetors, pistons, rings, valves |
| 327 | 500002 | Machinery, except electrical, n.e.c. |
| 328 | 510101 | Electrical computing equipment |
| 329 | 510102 | Calculating and accounting machines |
| 330 | 510300 | Scales and balances |
| 331 | 510400 | Typewriters and office machines, n.e.c. |
| 332 | 520100 | Automatic merchandising machines |
| 333 | 520200 | Commercial laundry equipment |
| 334 | 520300 | Refrigeration and heating equipment |
| 335 | 520400 | Measuring and dispensing pumps |
| 336 | 520500 | Service industry machines, n.e.c. |
| 337 | 530100 | Instruments to measure electricity |
| 338 | 530200 | Transformers |
| 339 | 530300 | Switchgear and switchboard apparatus |
| 340 | 530400 | Motors and generators |
| 341 | 530500 | Industrial controls |
| 342 | 530600 | Welding apparatus, electric |
| 343 | 530700 | Carbon and graphite products |
| 344 | 530800 | Electrical industrial apparatus, n.e.c. |
| 345 | 540100 | Household cooking equipment |
| 346 | 540200 | Household refrigerator and freezers |
| 347 | 540300 | Household laundry equipment |
| 348 | 540400 | Electric housewares and fans |
| 349 | 540500 | Household vacuum cleaners |
| 350 | 540600 | Sewing machines |

ITC CGE DATABASE SECTORS—Continued

| <i>Sector</i> | <i>BEA Sector^a</i> | <i>Description</i> |
|---------------|-----------------------------------|---|
| 351 | 540700 | Household appliances, n.e.c. |
| 352 | 550100 | Electric lamps |
| 353 | 550200 | Lighting fixtures and equipment |
| 354 | 550300 | Wiring devices |
| 355 | 560100 | Radio and TV receiving sets |
| 356 | 560200 | Phonograph records and tapes |
| 357 | 560300 | Telephone and telegraph apparatus |
| 358 | 560400 | Radio and TV communication equipment |
| 359 | 570100 | Electron tubes |
| 360 | 570200 | Semiconductors and related devices |
| 361 | 570300 | Other electronic components |
| 362 | 580100 | Storage batteries |
| 363 | 580200 | Primary batteries, dry and wet |
| 364 | 580300 | X-ray apparatus and tubes |
| 365 | 580400 | Engine electrical equipment |
| 366 | 580500 | Electrical equipment and supplies, n.e.c. |
| 367 | 590100 | Truck and bus bodies |
| 368 | 590200 | Truck trailers |
| 369 | 590301 | Motor vehicles and car bodies |
| 370 | 590302 | Motor vehicles parts and accessories |
| 371 | 600100 | Aircraft |
| 372 | 600200 | Aircraft and missile engines and engine parts |
| 373 | 600400 | Aircraft and missile equipment, n.e.c. |
| 374 | 610100 | Ship building and repairing |
| 375 | 610200 | Boat building and repairing |
| 376 | 610300 | Railroad equipment |
| 377 | 610500 | Motorcycles, bicycles, and parts |
| 378 | 610601 | Travel trailers and campers |
| 379 | 610602 | Mobile homes |
| 380 | 610603 | Motor homes |
| 381 | 610700 | Transportation equipment, n.e.c. |
| 382 | 620100 | Engineering and scientific equipment |
| 383 | 620200 | Mechanical measuring devices |
| 384 | 620300 | Environmental controls |
| 385 | 620400 | Surgical and medical instruments |
| 386 | 620500 | Surgical appliances and supplies |
| 387 | 620600 | Dental equipment and supplies |
| 388 | 620700 | Watches, clocks, and parts |
| 389 | 630100 | Optical instruments and lenses |
| 390 | 630200 | Ophthalmic goods |
| 391 | 630300 | Photographic equipment and supplies |
| 392 | 640101 | Jewelry, precious metal |
| 393 | 640102 | Jewelers' materials and lapidary work |
| 394 | 640104 | Silverware and plated ware |
| 395 | 640105 | Costume jewelry |
| 396 | 640200 | Musical instruments |
| 397 | 640301 | Games, toys, and children's vehicles |
| 398 | 640302 | Dolls |
| 399 | 640400 | Sporting and athletic goods, n.e.c. |
| 400 | 640501 | Pens and mechanical pencils |

ITC CGE DATABASE SECTORS—Continued

| <i>Sector</i> | <i>BEA Sector^a</i> | <i>Description</i> |
|---------------|-----------------------------------|--|
| 401 | 640502 | Lead pencils and art goods |
| 402 | 640503 | Marking devices |
| 403 | 640504 | Carbon paper and inked ribbons |
| 404 | 640600 | Artificial trees and flowers |
| 405 | 640701 | Buttons |
| 406 | 640702 | Needles, pins, and fasteners |
| 407 | 640800 | Brooms and brushes |
| 408 | 640900 | Hard surface floor coverings |
| 409 | 641000 | Burial caskets and vaults |
| 410 | 641100 | Signs and advertising displays |
| 411 | 641200 | Manufacturing industries, n.e.c. |
| 412 | 650100 | Railroads and related services |
| 413 | 650200 | Local, interurban passenger transit |
| 414 | 650300 | Motor freight transportation and warehousing |
| 415 | 650400 | Water transportation |
| 416 | 650500 | Air transportation |
| 417 | 650600 | Pipe lines, except natural gas |
| 418 | 650701 | Freight forwarders and other transportation services |
| 419 | 650702 | Arrangement of passenger transportation |
| 420 | 660000 | Communications, except radio and TV |
| 421 | 670000 | Radio and TV broadcasting |
| 422 | 680100 | Electric services (utilities) |
| 423 | 680200 | Gas production and distribution (utilities) |
| 424 | 680301 | Water supply and sewerage systems |
| 425 | 680302 | Sanitary services, steam, and irrigations systems |
| 426 | 690100 | Wholesale trade |
| 427 | 690200 | Retail trade |
| 428 | 700100 | Banking |
| 429 | 700200 | Credit agencies other than banks |
| 430 | 700300 | Security and commodity brokers |
| 431 | 700400 | Insurance carriers |
| 432 | 700500 | Insurance agents, brokers and services |
| 433 | 710100 | Owner-occupied dwellings |
| 434 | 710200 | Real estate |
| 435 | 720100 | Hotels and lodging places |
| 436 | 720201 | Laundry, cleaning, and shoe repair |
| 437 | 720202 | Funeral service and crematories |
| 438 | 720203 | Photo studios and misc. personal services |
| 439 | 720204 | Electrical repair shops |
| 440 | 720205 | Watch, clock, jewelry, furniture repair |
| 441 | 720300 | Beauty and barber shops |
| 442 | 730101 | Miscellaneous repair shops |
| 443 | 730102 | Services to buildings |
| 444 | 730103 | Personal supply services |
| 445 | 730104 | Computer and data processing services |
| 446 | 730105 | Management and consulting services |
| 447 | 730106 | Detective and protective services |
| 448 | 730107 | Equipment and rental leasing |
| 449 | 730108 | Photofinishing, commercial photography |
| 450 | 730109 | Other business services |

ITC CGE DATABASE SECTORS—Continued

| <i>Sector</i> | <i>BEA Sector^a</i> | <i>Description</i> |
|---------------|-----------------------------------|--|
| 451 | 730200 | Advertising |
| 452 | 730301 | Legal services |
| 453 | 730302 | Engineering, architectural services |
| 454 | 730303 | Accounting, auditing and bookkeeping, n.e.c. |
| 455 | 740000 | Eating and drinking places |
| 456 | 750001 | Automotive rental and leasing |
| 457 | 750002 | Automotive repair shops and services |
| 458 | 750003 | Automobile parking and car washes |
| 459 | 760100 | Motion pictures |
| 460 | 760200 | Dance halls, studios and schools |
| 461 | 760201 | Theatrical producers, bands etc. |
| 462 | 760202 | Bowling alleys and pool halls |
| 463 | 760203 | Commercial sports except racing |
| 464 | 760204 | Racing and track operations |
| 465 | 760205 | Membership sports and recreation clubs |
| 466 | 760206 | Other amusement and recreation services |
| 467 | 770100 | Doctors and dentists |
| 468 | 770200 | Hospitals |
| 469 | 770301 | Nursing and personal care facilities |
| 470 | 770302 | Other medical and health services |
| 471 | 770401 | Elementary and secondary schools |
| 472 | 770402 | Colleges, universities, and professional schools |
| 473 | 770403 | Other educational services |
| 474 | 770501 | Business associations |
| 475 | 770502 | Labor and civic organizations |
| 476 | 770503 | Religious organizations |
| 477 | 770504 | Other membership organizations |
| 478 | 770800 | Residential care |
| 479 | 770900 | Social services, n.e.c. |
| 480 | 780100 | U.S. Postal Service |
| 481 | 780200 | Federal electric utilities |
| 482 | 780400 | Other federal government services |
| 483 | 790100 | Local government passenger transit |
| 484 | 790200 | State and local electric utilities |
| 485 | 790300 | Other state and local government enterprises |
| 486 | 820000 | Government industry |

^a U.S. Bureau of Economic Analysis sector.

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