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The USDA/ERS Computable General Equilibrium (CGE) Model of the United States

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Abstract

This paper documents the basic Computable General Equilibrium (CGE) model of the U.S. economy developed at the Economic Research Service (ERS), USDA. The paper both describes the model equations in detail and how the model is "benchmarked" to a base data set. The paper also lists the computer program used to implement the model. The objective of the CGE work program at ERS is to provide a multisectoral framework for analyzing the effect of changes in agricultural policies and exogenous shocks on the farm sector, on the rural economy, on related nonagricultural sectors, and on the rest of the economy. The basic model has provided a starting point for a variety of extensions and applications exploring a number of policy issues. To date, work has largely focused on issues of agricultural trade policy and the effect of alternative domestic policies.

Keywords: Computable general equilibrium (CGE) model of the U.S. economy, social accounting matrix (SAM) of the U.S. economy, and GAMS modeling software.

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Introduction

This paper documents a basic Computable General Equilibrium (CGE) model of the U.S. economy emphasizing agriculture and international trade.[1] Different versions of the basic CGE model have been used at the USDA to investigate a number of policy issues. To date, work has focused on issues of trade policy. A 10-sector version of the model has been used to analyze the impact of different proposals for liberalizing domestic and border policies concerning agriculture that have been suggested as part of the current negotiations in the Uruguay Round (1986-90) of the General Agreement on Tariffs and Trade (GATT).[2]

An early version of the model was also used to analyze the impact on the structure of the U.S. economy of macro shocks in the 1982-86 period by Adelman and Robinson (1988). A different version of the same model was also used to analyze the impact on the economy of cutting defense expenditures by Roland-Holst, Robinson, and Tyson (1988). Work underway at the International Trade Commission to develop an in-house CGE modeling capability starting from the USDA model is discussed in Roland-Holst and Tokarick (1989).

Work is underway at the USDA to expand the model to include more sectoral detail and to extend the specification in new directions.[3] The objective is to provide a multisectoral

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[1]The model was developed at the Economic Research Service (ERS), U.S. Department of Agriculture (USDA). Work on the model was part of the Intersectoral Policy and Performance Project in the National Aggregate Analysis Section, National Economy and History Branch, Agriculture and Rural Economy Division (NAA/NEH/ARED).
[2]See Robinson, Kilkenny, and Adelman (1989) and Kilkenny and Robinson (1988, 1990). For surveys of other analyses of agricultural trade liberalization using CGE models, see Robinson (1990) and Hertel (1990).
[3]These extensions are discussed below.

framework for analyzing the impact of changes in agricultural policies and exogenous shocks on the farm sector, on the rural economy, on related nonagricultural sectors, and on the rest of the economy.

The USDA CGE model is part of a long tradition of CGE models of the United States. These models focused on issues such as public finance, energy, industrial trade, the impact of import quotas, and the costs of pollution control. Examples include: Ballard, Fullerton, Shoven, and Whalley (1985); Hertel and Tsigas (1988); Hudson and Jorgenson (1974); Shoven and Whalley (1984); de Melo and Tarr (forthcoming); Goulder and Eichengreen (1989); and Jorgenson and Wilcoxen (1989).

A variety of approaches have been used to implement CGE models. The USDA model is implemented using a software package called GAMS (General Algebraic Modeling System).[4] The GAMS software represents an important advance in implementing CGE models because its algebraic language provides a concise way to specify model equations. The GAMS program provides complete model documentation, and the model specification is independent of the solution algorithm. In the past, modelers developed their own application-specific software, which made the models difficult or impossible to transfer to others. A CGE model written in the GAMS equation language can be run on a wide variety of computers, including PC's.

The next two sections provide a brief description of the CGE model and its overall structure in a social accounting framework. A complete description of the model equations is presented in the section following these two sections. We then discuss how the model is calibrated using data from a balanced Social Accounting Matrix (SAM) for the U.S. economy, and describe how we implement the model in the GAMS software. Finally, we discuss applications, variations, and alternative model specifications.

Major Features of the CGE Model

A CGE model simulates the working of a market economy in which prices and quantities adjust to clear markets for products and factors. The model specifies the behavior of optimizing consumers and producers in the market economy. It also includes the government as an explicit agent (although not an optimizer) and captures all transactions in the circular flow of income.

The model is constructed to focus on issues of international trade and incorporates imperfect substitution between imports and domestic goods in demand. There is a parallel treatment of export supply, with imperfect transformability between production

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[4]The GAMS package is described in detail in Brooke, Kendrick, and Meeraus (1988). The first CGE model implemented in GAMS was a model of Cameroon described in Condon, Dahl, and Devarajan (1987).

for domestic and foreign markets at the sectoral level. These features are characteristic of a large number of CGE models applied to developing countries to study issues of structural adjustment.[5] The theoretical properties of this model with "semitradables" have been extensively documented, and it can be seen as an extension of the Salter-Swan "Australian" trade model, which incorporates nontraded goods.[6]

This treatment of exports and imports realistically insulates the domestic price system from changes in world prices of sectoral substitutes. The model also makes the "small country" assumption on the import side, assuming that the United States cannot affect world prices of its imports. On the export side, we assume downward sloping world demand functions for some U.S. agricultural commodities. All other exports have fixed world prices.

Each sector produces a composite commodity that can be transformed into an export or a commodity sold on the domestic market. Each industry's output is produced according to a production function which uses primary and intermediate inputs. Sectoral input demands are derived from first order conditions for profit maximization.

Two modes of market behavior for primary factors (labor, capital, and land) may be modeled. In a "shortrun" version, capital is assumed to be sectorally fixed, and the final equilibrium will have sectorally differentiated rental rates. In a "longrun" version, all factors are mobile and average factor returns adjust to clear factor markets with full employment.

Aggregate domestic demand in the model has four components: consumption, intermediate demand, government, and investment (including inventory change). Household expenditure functions are derived from utility maximization. Each household pays income taxes to the government and saves a proportion of its income. Intermediate demand is given by fixed input-output coefficients. For the government, aggregate real spending on goods and services is exogenous. Inventory demand by sector is a fixed proportion of domestic output. The model distinguishes fixed investment by sector of destination and demand for investment goods by sector of origin. Investment demand by sector of origin is translated from investment demand by sector of destination by using a capital composition matrix.

The CGE model includes the major macro balances: savings-investment, government deficit, and the balance of trade.

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[5]For surveys of this literature, see Robinson (1989a,b) and de Melo (1988). There are also a number of multi-country CGE models. For a survey, see Shoven and Whalley (1984).
[6]See Salter (1959), Swan (1960), and Armington (1969). The properties of this approach are explored by Dervis, de Melo, and Robinson (1982); de Melo and Robinson (1981, 1985, 1989); Devarajan, Lewis, and Robinson (1990); and Brown (1987).

Aggregate investment is either set exogenously from a macro model or is "savings driven." Aggregate savings is the sum of enterprise-retained earnings plus capital consumption allowance, household saving, government saving, and foreign saving. Government saving is the difference between revenue and spending. Alternative approaches to reconciling aggregate savings and investment are discussed below.

In the balance of trade equation, the value of imports at world prices must equal the value of exports at world prices plus foreign savings, net remittances, and net foreign borrowing by the U.S. Government. Two alternative equilibrating mechanisms are possible. First, the balance of trade is specified exogenously and the real exchange rate adjusts to achieve equilibrium. Second, the exchange rate is exogenous and the balance of trade is assumed to adjust.

The CGE model solves only for relative prices. We choose as the numeraire price index the GNP price deflator. Given the choice of numeraire, the model solves for all relative factor returns and prices that clear the markets for factors and products. The model also solves for the equilibrium value of the real exchange rate, given the exogenously set balance of trade.

SAM Structure of the Model

A Social Accounting Matrix (SAM) provides a tabular snapshot of the economy at one point in time. Figure 1 presents a descriptive SAM for the United States that shows the transactions among agents in the economy captured in the CGE model.[7] The structure of the SAM is consistent with the U.S. National Income and Product Accounts (NIPA). The treatment of exports as a delivery from activities to the rest of the world, rather than going through the commodity account, reflects the model's specification of producers as "transforming" goods for delivery to the domestic and export markets. This treatment has the added advantage of making the commodity account in the SAM measure the trade-theory notion of "absorption," or total supply of goods to the domestic economy.[8]

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[7]For an introduction to Social Accounting Matrices, see King (1985) and United Nations (1968). The seminal work was done by Richard Stone and is described in Stone (1986). Pyatt and Round (1985) provide a number of examples of the uses of SAM's. Hanson and Robinson (1989) provide the mapping for the United States from the NIPA to a SAM framework.

[8]In the U.S. input-output accounts, exports are part of the commodity account. A "make" matrix is used to transform activities to commodities, with all intermediate and final demands (including exports) specified as demands for commodities. Our treatment, separating export and domestic demand, is consistent with our modeling perspective.

Figure 1--A Descriptive Social Accounting Matrix (SAM)

		1 Suppliers Commodity	2 Suppliers Activity	3 Value added Labor	4 Value added Capital	5 Institutional actors Enterprise	6 Institutional actors Household	7 Institutional actors Government	8 Institutional actors Capital	9 Institutional actors World	Row totals
	EXPENDITURES OR OUTLAYS										
R E C E I P T S O R I N C O M E	**Suppliers**										
	1 Commodity		intermediate demand				household consumption	government purchases	investment		domestic sales
	2 Activity	domestic supply						export subsidies		exports	total sales
	Value added										
	3 Labor		employee compensation								employee compensation
	4 Capital		capital income								capital income
	Institutional actors										
	5 Enterprise				gross bus. income			transfers to bus.			enterprise income
	6 Household			labor income		distributed profits		transfers		net foreign remittances	household income
	7 Government	tariff	indirect tax	social security tax		business profit tax	household income tax			net foreign transfers	government income
	8 Capital		.			bus. savings +depreciation	household savings	government savings		net foreign savings	total savings
	9 World	imports									foreign income
	Column totals	total absorption	total costs	employee compensation	capital income	enterprise expenditure	household expenditure	government expenditure	total investment	foreign expenditure	

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Each nonzero cell in the SAM represents the value of an economic transaction between actors. The model equations describe every entry in the SAM. The accounts in the SAM effectively define the transactions and income flows among five basic actors in the economy: suppliers/enterprises, households, government, capital account, and rest of world. A row documents the income to an account, the corresponding column documents the outflow, and the row and column sums must balance for each account. In equilibrium, this balance implies: (1) costs (plus distributed earnings) exhaust revenues for producers, (2) expenditure (plus taxes and savings) equals income for each agent in the model, and (3) demand equals supply of each commodity.

The first two rows and columns of the SAM capture the workings of the product and factor markets. The row of the commodity account describes the domestic product market, with the supply to domestic users. The column of the commodity account keeps track of absorption, which equals the value of domestic products sold on the domestic market, and imports, including tariffs.

Column two describes the demand for factors of production and intermediate inputs. Producers pay out value added to factors and indirect taxes to government down the column, and sell goods on the domestic and foreign markets along the row. Export subsidies are seen as a payment by government to producers. Exports and imports in the account for the rest of the world are valued in world market prices times the exchange rate.

The next two rows and columns (3 and 4) describe the payment of value added to primary factors and its distribution to institutional actors. The last five rows and columns (5 to 9) describe inter-institutional transfers and the generation of demand for goods in the product markets. The last three accounts (7 to 9) capture the major macro balances: government deficit, savings-investment, and balance of trade.

Three types of transactions occur among the actors. First, there are "market transactions," with goods and services (including factor services) flowing from rows to columns and corresponding payments flowing from columns to rows. These are given in the first two rows and columns of the SAM plus the last row and column. Second, there are "transfers," either voluntary or involuntary, involving nominal flows from column accounts but no real flows from the row accounts. Accounts 3 to 7 involve this type of transaction, essentially mapping the flow of funds in the economy. Tax payments can be viewed as involuntary transfers, while the rest can be seen as voluntary.

Finally, there are "financial transactions." In the SAM, these are all captured in the single "capital" account, which summarizes the workings of all financial markets. This account collects savings from the various actors along the row and uses the proceeds to purchase capital goods ("investment") in cell (1,8). In the capital account row, agents presumably receive title to assets in return for depositing their savings. Financial transactions in the capital account implicitly define

the market for new assets, with the supply of new assets equaling the value of aggregate investment. The CGE model, however, is defined only in terms of flows and determines a flow equilibrium for a single period. The model has no assets, money, interest rates, expectations, or dynamics.

Equations of the CGE Model

The order of the presentation of the equations follows the generation and flow of income from producers to households. First, we present equations defining the price system, followed by equations describing production and the generation of value added. The next block of equations describes the mapping of value added into institutional income. The following block completes the circular flow, describing the demand for goods by the various actors. Finally, there are a number of "system constraints" that the model economy must satisfy. These include market-clearing conditions and macro "closure" equations. A summary table of all the equations is provided in Appendix 1.

In the basic model, the U.S. economy is disaggregated into 10 sectors. There are three primary factors of production, three categories of households, and three "institutions" which serve as intermediaries in mapping factor income to household income. Table 1 lists the various indices, describes the sets they represent, and presents the definitions of all variables and parameters. Tables 2 through 6 list the model equations as they are described. Following the equation number in these tables is an index, or number, for counting equations. The counting of equations and variables is tabulated in table 7.

GAMS notation is used throughout this section. While close to standard algebra, GAMS has some differences. There are a few differences in operator notation. The summation operator is written "SUM," with the index of summation and the arguments written in parentheses separated by a comma. For example: $\Sigma_i\, X_i$ is written SUM(i, X(i)) in GAMS. The product operator is "PROD," and the algebraic expression $\Pi_i\, X_i$ is written PROD(i, X(i)). The GAMS language allows a great deal of flexibility in describing equations, including inequalities and Boolean relationships. We do not need these extensions in the presentation of the basic model equations. Some are used in the listing of the GAMS version of the model given in Appendix 2.

Some notational conventions are followed consistently. Endogenous variables are presented in upper case, while parameters, exogenous variables, and indices are always lower case. In a few equations, an index is replaced by a specific entry (given in quotes).

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Table 1--Definitions of indices, variables, and parameters

Indices

i, j	Sectors
im	Sectors with imports
imn	Sectors without imports: im + inm = i
ie	Sectors with exports
ien	Sectors without exports: ie + ien = i
ied	Sectors with world export demand functions
f	Factors of production: labor, capital, and land
ins	Institutions: labr, prop, and ent (Labor, property, and enterprises)
hh	Households

Variables

Prices block

EXR	Exchange rate
P(i)	Price of composite good
PD(i)	Domestic sales price
PE(i)	Domestic price of exports
PINDEX	GNP deflator
PK(i)	Price of a unit of capital in each sector
PM(i)	Domestic price of imports
PVA(i)	Value-added price
PWE(i)	World price of exports
PX(i)	Output price

Production block

E(i)	Exports
FDSC(i,f)	Factor demand
INT(i)	Intermediate input demand
M(i)	Imports
WF(f)	Average factor price
X(i)	Composite goods supply
XD(i)	Domestic output
XXD(i)	Domestic sales

Income and expenditure blocks

CD(i)	Final demand for private consumption
DEPRECIA	Total depreciation charges
DK(i)	Fixed investment by sector of destination
DST(i)	Inventory investment by sector
ENTSAV	Enterprise savings
ENTTAX	Enterprise tax revenue
FBOR	Net foreign borrowing
FXDINV	Fixed capital investment
FSAV	Foreign savings
GD(i)	Final demand for government consumption
GDTOT	Aggregate real government consumption
GENT	Transfer payments from government to enterprises
GNPVA	Nominal GNP or value added in market prices
GOVSAV	Government savings
GR	Total government revenue
HHSAV	Total household savings
HHT	Government transfer payments to households
ID(i)	Final demand for investment goods
INDTAX	Total indirect tax revenue

Continued--

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Table 1--Definitions of indices, variables, and parameters--Continued

INVEST	Total investment
NETSUB	Total export subsidies
REMIT	Net remittances from abroad
RGNP	Real GNP
SAVINGS	Total savings
SSTAX	Social security tax revenue
TARIFF	Tariff revenue
TOTHHTAX	Household tax revenue
YFCTR(f)	Factor income
YH(hh)	Household income
YINST(ins)	Institutional income

Parameters

ac(im)	CES function shift parameter
ad(i)	Production function shift parameter
alpha(i,f)	Share parameter in production function
at(ie)	CET function shift parameter
cles(i,hh)	Household expenditure shares
delta(im)	CES function share parameter
depr(i)	Depreciation rate
dstr(i)	Ratio of inventory investment to domestic output
econst(ied)	Export demand function shift parameter
esr	Enterprise saving rate
etr	Enterprise tax rate
fs(f)	Aggregate factor supply
gamma(ie)	CET function share parameter
gles(i)	Government expenditure shares
htax(hh)	Household income tax rate
imat(i,j)	Capital composition matrix
io(i,j)	Input-output coefficients
itax(i)	Indirect business tax rate
kish(i)	Shares of investment by sector of destination
mps(hh)	Household saving rate
pwm(im)	World price of imports
pwse(ied)	World price of export substitutes
rhoc(im)	CES function exponent
rhot(ie)	CET function exponent
rhsh(hh)	Household remittance share
sintyh(hh,ins)	Household distribution of institutional income
sstr	Social security tax rate
tm(im)	Tariff rate on imports
tmreal(im)	Real tariff rate
te(ie)	Export subsidy rates
tereal(ie)	Real export subsidy rate
thsh(hh)	Household share of government transfers
wfdist(i,f)	Factor market distortion parameters

Table 2--Price equations

(1)	im	PM(im)	= pwm(im)*(1 + tm(im))*EXR
(2)	ie	PE(ie)	= PWE(ie)*(1 + te(ie))*EXR
(3)	i	P(i)	= (PD(i)*XXD(i) + PM(i)*M(i))/X(i)
(4)	i	PX(i)	= (PD(i)*XXD(i) + PE(i)*E(i))/XD(i)
(5)	i	PVA(i)	= PX(i)*(1 - itax(i)) - SUM(j, io(j,i)*P(j))
(6)	i	PK(i)	= SUM(j, P(j)*imat(j,i))
(7)	1	PINDEX	= GNPVA/RGNP

Price Equations

Table 2 presents the model's price system. On the import side, the model incorporates the "small country" assumption: world prices (pwm) are exogenous. The domestic price of imports (PM) is simply the tariff-ridden world price times the exchange rate (EXR). On the export side, for some agricultural sectors, there is assumed to be a downward-sloping world demand curve for U.S. exports. For these sectors, the world price (PWE) is endogenous. The domestic price of exports, PE, includes any export subsidies.

Equations 3 and 4 describe the prices for the composite commodities X and XD. These equations reflect the homogeneity of the import aggregation and export transformation functions. The value of the composites must equal the value of their component parts, regardless of functional form. We discuss below the properties of the functions.[9]

Equation 5 defines the sectoral value-added or "net" price (PVA). It equals the output price minus indirect taxes and the cost of intermediate inputs (given fixed input-output coefficients).[10] The expression PVA·XD equals sectoral value added (at factor cost), which is paid to primary factors.

Equation 6 gives the price (PK) of a unit of capital installed in sector i. PK differs across sectors, reflecting the fact that capital used in different sectors is heterogeneous. The composition of capital goods used by a sector (by sector of origin) is given by the columns of the matrix imat. Because each column of imat sums to one, PK(i) is simply the weighted average of the costs of capital goods used in sector i.

Finally, equation 7 defines an aggregate price index (PINDEX), which is the GNP deflator. It equals nominal GNP (GNPVA) divided

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[9]In some models, it is convenient to use the dual price equations and drop the CES aggregation and CET transformation functions. For these functions, the two treatments are equivalent. When using flexible functional forms that are not self-dual, alternative treatments can matter.

[10]Note that indirect tax rates are computed on a base of PX. In other models, they are computed on a base of PD. See, for example, Devarajan, Lewis, and Robinson (1990).

by real GNP (RGNP). This is the numeraire price index that will
be fixed, defining the absolute price level against which all
relative prices will be measured. The GNP deflator is a
convenient choice, but any other price index could be used.
Other common choices in CGE models include a consumer or producer
price index, the exchange rate, or the wage.

Quantity Equations

Table 3 gives the block of quantity equations, which effectively
determine the supply side of the model. Equations 8 to 10 define
the production technology and sectoral demand for factors.
Equations 11 to 13 give the export transformation functions and
the corresponding export supply functions, which depend on
relative prices (PE/PD). Equation 14 gives the world demand
functions for exports in sectors in which the United States is
assumed to face a downward-sloping world demand curve (indexed by
ied). Equations 15 to 17 give the import aggregation functions
and the corresponding import demand functions, which depend on
relative prices (PD/PM).

Equation 8 defines a Cobb-Douglas value-added production function
with primary factors FDSC (including labor, capital, and land).
The demand for intermediate inputs is given by equation 10, which
assumes fixed input-output coefficients. The demand for primary
factors, equation 9, reflects the first-order conditions for
profit maximization using the value-added price, PVA. Given that
the value-added price appears in equation 9, there is no need to
define a separate variable for real value added. Consequently,
XD appears in equations 8 and 9.

The model will solve for average factor prices, WF(f), that clear
the factor markets. The model also allows for factor-market
distortions. The parameters wfdist(i,f) are assumed fixed and

Table 3--Quantity equations
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(8)	i	XD(i)	= ad(i)*PROD(f, FDSC(i,f)**alpha(i,f))
(9)	i,f	WF(f)*wfdist(i,f) = PVA(i)*alpha(i,f)*XD(i)/FDSC(i,f)	
(10)	i	INT(i)	= SUM(j, io(i,j)*XD(j))
(11)	ie	XD(ie)	= at(ie)*(gamma(ie)*E(ie)**rhot(ie)
			+ (1-gamma(ie))*XXD(ie)**rhot(ie))**(1/rhot(ie))
(12)	ien	XD(ien)	= XXD(ien)
(13)	ie	E(ie)	= XXD(ie)*(PE(ie)/PD(ie)*(1 - gamma(ie))
			/gamma(ie))**(1/(rhot(ie)-1))
(14)	ied	E(ied)	= econst(ied)*((PWE(ied)
			/pwse(ied))**(-rhoe(ied)))
(15)	im	X(im)	= ac(im)*(delta(im)*M(im)**(-rhoc(im))
			+ (1-delta(im))*XXD(im)**(-rhoc(im)))**(-1/rhoc(im))
(16)	imn	X(imn)	= XXD(imn)
(17)	im	M(im)	= XXD(im)*((PD(im)/PM(im))*(delta(im)
			/(1-delta(im))))**(1/(1+rhoc(im)))
_____

measure the extent to which the marginal revenue product of a factor in a particular sector deviates from the average return for that factor across the economy. If there are no distortions in the factor markets, all the wfdist(i,f) parameters will equal one.

Total domestic production (XD) is supplied to domestic (XXD) or foreign (E) markets. The three goods are distinct, with separate prices, although they have the same sectoral classification. In effect, each sector is a two-product firm, producing goods for the export and domestic market. Equation 11 describes how sectoral production is transformed into goods for domestic markets and export markets.

The functional form of equation 11 is a constant elasticity of transformation (CET) function. Producers maximize revenue from sales subject to the CET transformation function. Export supply, equation 13, represents the first-order conditions and is a function of the relative export price to domestic price, the elasticity of transformation between the two uses, and the share parameters in the CET function.

Imported (M) and domestic goods (XXD) are also distinct, with separate sectoral prices. Consumers demand a composite good, which is a CES aggregate of imported and domestic goods with the same sectoral classification (equation 15). Import demand is given by equation 17, which is the first order condition for minimizing the cost of buying a given amount of composite good. The model thus allows cross-hauling (that is, simultaneous exports and imports) at the sectoral level.[11]

This treatment of exports and imports partially insulates the domestic price system from changes in world prices of sectoral substitutes. The specification of imperfect substitution and transformation is more realistic than the extreme dichotomy between perfect substitutes and nontraded goods commonly specified in analytic trade models. The particular functional forms used (CES and CET functions) embody strong assumptions about separability and the absence of income effects. The ratio of exports and imports to domestic sales at the sectoral level depends only on relative prices, with no income effects. These strong assumptions can be weakened without losing the fundamental assumption that domestic and foreign goods are imperfect substitutes. Hanson, Robinson, and Tokarick (1990), for example, specify import demand according to a flexible functional form, the Almost Ideal Demand System (AIDS). The AIDS system allows for a non-unitary income elasticity of demand for imports at the sectoral level.

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[11]The model also allows pure nontraded goods. In sectors with no exports or imports (indices ien and imn), the aggregation functions are not needed (equations 12 and 16).

Table 4--Income equations

(18)	f	YFCTR(f)	= SUM(i, WF(f)*wfdist(i,f)*FDSC(i,f))
(19)	1	YINST("labr")	= YFCTR("labor") - SSTAX
(20)	1	YINST("prop")	= YFCTR("land")
(21)	1	YINST("ent")	= YFCTR("capital") + GENT - ENTSAV - ENTTAX - DEPRECIA
(22)	hh	YH(hh)	= SUM(ins, sintyh(hh,ins)*YINST(ins)) + rhsh(hh)*REMIT*EXR + thsh(hh)*HHT
(23)	1	TARIFF	= SUM(im, tm(im)*pwm(im)*M(im))*EXR
(24)	1	INDTAX	= SUM(i, itax(i)*PX(i)*XD(i))
(25)	1	NETSUB	= SUM(ie, te(ie)*PWE(ie)*E(ie))*EXR
(26)	1	SSTAX	= sstr*YFCTR("labor")
(27)	1	ENTTAX	= etr*(YFCTR("capital") - DEPRECIA + GENT)
(28)	1	TOTHHTAX	= SUM(hh, htax(hh)*YH(hh))
(29)	1	DEPRECIA	= SUM(i, depr(i)*PK(i)*FDSC(i,"capital"))
(30)	1	ENTSAV	= esr*(YFCTR("capital") + GENT - ENTTAX - DEPRECIA)
(31)	1	HHSAV	= SUM(hh, mps(hh)*YH(hh)*(1 - htax(hh)))
(32)	1	GR	= TARIFF - NETSUB + INDTAX + TOTHHTAX + SSTAX + ENTTAX + FBOR*EXR
(33)	1	SAVINGS	= HHSAV + GOVSAV + DEPRECIA + FSAV*EXR + ENTSAV

Income Equations

Table 4 presents the equations that map the flow of income from value added to institutions and ultimately to households. Factor incomes (YFCTR) are defined in equation 18. They are mapped into institutional incomes (YINST) in equations 19 to 21, net of institutional taxes, savings, and government transfers. Using fixed allocation shares (sintyh), institutional income is distributed to households in equation 22. Households also receive income as remittances from abroad (generally negative for the United States) and transfers from the government. Taxes are determined in equations 23 to 28, and total government revenue is given in equation 32. Savings, including depreciation charges, are given in equations 29 to 31 and are summed in equation 33.

These income equations serve to fill out all the inter-institutional entries in the SAM. Many of these entries will be specific to the institutional structure of a particular country. For example, government revenue includes a term FBOR·EXR. In the U.S. accounts, this variable is net foreign transfers received by the U.S. Government (generally negative for the United States), minus net interest paid by the Government to foreigners on outstanding official debt. While they are listed as variables, many of these items will be set exogenously in the model or determined by simple share or multiplier parameters.

Table 5--Expenditure and equilibrium equations

Expenditure equations:

```
(34) i   P(i)*CD(i) = SUM(hh, cles(i,hh)*(1 - mps(hh))*YH(hh)
                          *(1 - htax(hh)))
(35) i   GD(i)      = gles(i)*GDTOT
(36) i   DST(i)     = dstr(i)*XD(i)
(37) 1   FXDINV     = INVEST - SUM(i, DST(i)*P(i))
(38) i   PK(i)*DK(i) = kish(i)*FXDINV
(39) i   ID(i)      = SUM(j, imat(i,j)*DK(j))
(40) 1   GNPVA      = SUM(i, PVA(i)*XD(i)) + INDTAX + TARIFF - NETSUB
(41) 1   RGNP       = SUM(i, CD(i) + DST(i) + ID(i) + GD(i))
                          + SUM(ie, (1 - tereal(ie))*E(ie))
                          - SUM(im, (1 - tmreal(im))*M(im))
```

Equilibrium equations:

```
(42) i   X(i)       = INT(i) + CD(i) + GD(i) + ID(i) + DST(i)
(43) f   SUM(i, FDSC(i,f))= fs(f)
(44) 1   GR         = SUM(i, P(i)*GD(i)) + GOVSAV + GENT + HHT
(45) 1   SUM(im, pwm(im)*M(im))= SUM(ie, PWE(ie)*E(ie)) + FSAV
                                    + REMIT + FBOR
(46) 1   SAVINGS    = INVEST
```

Expenditure and Equilibrium Equations

Table 5 gives equations that complete the circular flow of income and expenditure, determining the demands for goods by the various actors. Consumer expenditures, equation 34, are a function of prices and income according to a simplified version of the Linear Expenditure System (LES).[12] Government demand for final goods, equation 35, is defined in terms of fixed shares (gles parameter) of aggregate real government spending on goods and services (GDTOT). Equation 44 is the government balance equation, equating revenue and expenditure (including the deficit).

Equations 36 to 39 determine the demand for capital goods. The demands for new inventories (DST) are given by fixed coefficients times production (equation 36). Aggregate nominal fixed investment (FXDINV) equals total nominal investment (INVEST) minus the value of inventory accumulation (equation 37). Equation 38 determines fixed real investment by sector of destination (DK). The allocation of nominal fixed investment to sectors is given by fixed shares (kish), which sum to one over all sectors. Equation 39 translates investment by sector of destination into demand for capital goods by sector of origin, using the capital composition matrix (imat). Given the

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[12]In this case, all subsistence minima are set to zero. The LES reduces to fixed expenditure shares and a Cobb-Douglas utility function.

definition of PK(i), that SUM(i, kish(i)) = 1, and that
SUM(i, imat(i,j)) = 1 for all j, then it will be true that:

FXDINV = SUM(i, PK(i)·DK(i)) = SUM(i, P(i)·ID(i)).

The basic CGE model is static, with the economywide capital stock
specified as an exogenous variable. The model does generate
savings, investment, and demands for capital goods. The capital
goods, however, are assumed not to be installed during the
period, and so simply represent a separate demand category. In a
dynamic model, the assumption of heterogeneity of capital goods
by sector of destination is very important, affecting the dynamic
properties of different growth paths. In a static model, the
assumption is less important, but does have some impact because
different assumptions about the composition of investment by
sector of destination will change the structure of demand. The
specification of PK as sectorally differentiated reflects this
assumption.[13]

Equations 40 and 41 define real and nominal GNP, which are used
to define the GNP deflator in the price equation block. Defining
GNP from the expenditure side, imports are valued at world prices
times the exchange rate, net of tariffs. In defining value
added, imports are purchased by producers at domestic market
prices, which include tariffs. To make GNP calculated as the sum
of value added (at market prices) consistent with GNP calculated
from the expenditure side, tariffs must be added to total value
added, which is done in equation 40.[14] In the definition of
real GNP, real imports are defined net of "real" tariffs, given
the real tariff rates tmreal(i).[15]

In principle, exports should be treated symmetrically with
imports. In the national accounts, exports are valued at world
prices times the exchange rate, so that export subsidies need to
be netted out from the value added side, which is done in
equation 40. Note that, unlike tariffs, export subsidies are
distributed to producing sectors. In defining sectoral value
added at market prices, they can be treated symmetrically with
indirect taxes. Note also that PVA, defined in equation 5,
includes export subsidies but excludes indirect taxes.[16]

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[13]Other U.S. models that have focused on tax analysis have
all assumed that capital is not heterogeneous. See, for example,
Ballard, Fullerton, Shoven, and Whalley (1985). In such a model,
PK is a scalar and imat is a vector.
    [14]In the U.S. National Income and Product Accounts (NIPA),
tariffs are added to value added in the wholesale trade sector.
The United Nations system of national accounts (SNA) keeps
tariffs as a separate entry in the value added accounts.
    [15]This treatment is standard in national accounting, with
tmreal(i) defined as the tariff rates in the base year. Not all
countries define "real" tariffs this way. Some deflate nominal
tariffs by some deflator, say that for imports.
    [16]The tereal(i) parameters are needed on the export side
because it is customary to define real magnitudes in the base

Equations 42 to 46 define the system constraints that the model economy must satisfy. The model is a general equilibrium system, with all endogenous variables being jointly determined. In discussing how the economy satisfies these system constraints, however, it is useful to think in terms of equilibrium conditions and equilibrating variables. In a competitive market economy, market clearing is achieved by varying prices, and it is helpful to identify the price associated with each market.

Equation 42 states that the sectoral supply of composite commodities must equal demand and defines market-clearing equilibrium in the product markets. There is also an analogous sectoral market-clearing condition for domestically produced goods sold on the domestic market (XXD). However, from equation 17, the ratio of imports to domestic sales is assumed to be the same for all categories of demand. Thus, at the sectoral level, specifying a separate market-clearing condition for domestically produced goods sold on the domestic market amounts to multiplying through both sides of equation 42 by the ratio $XXD(i)/X(i)$. A separate equation for domestically produced goods sold on the domestic market is not needed. When the market for composite goods clears, then so will the market for domestic goods.

Equation 43 defines equilibrium in the factor markets. The supplies of primary factors (fs) are assumed fixed exogenously and are given as parameters. Market clearing requires that total factor demand equal supply. The equilibrating variables are the average factor prices, $WF(f)$. In the model as specified, all factors are freely mobile, including capital. The model must be seen as defining a longrun equilibrium in which sectoral capital stocks have time to adjust, equating rental rates across sectors.[17]

An alternative approach is to specify a shortrun model, with sectoral capital stocks fixed exogenously. Such a specification is easy to implement in the existing model structure. Fixing sectoral capital stocks amounts to making the $FDSC(i,f)$ variables exogenous for the factor "capital." The corresponding factor market-clearing equation is redundant and can be dropped. With sectorally fixed capital stocks, however, it is not possible to assume that the rental rate will be the same across sectors. This condition can be relaxed in the model by simply specifying the wfdist(i,"capital") parameters as endogenous variables

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year such that $PE(i) = 1$, and we assume that PE is a subsidy-ridden price (see equation 2 in table 3). There is less consistency across countries in the treatment of export subsidies than in the treatment of tariffs. Many countries appear to value exports in their accounts at subsidy-ridden prices. Since export subsidies are forbidden under the GATT, national statistical agencies tend to assume they do not exist. In the United States, there were no export subsidies in 1982, the base year for the model.

[17]With the wfdist parameters, sectoral rental rates are not equated, but may differ from the average by the fixed ratios.

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instead of parameters, adding n new equilibrating variables, and dropping the average factor return variable.[18] This treatment allows all sectoral rental rates to be determined endogenously, given the fixed sectoral capital stocks.

Macroeconomic Closure

The income and expenditure equations capture the three major macro balances: savings-investment, government deficit, and the balance of trade. Because the model is closed in that it satisfies Walras' Law, the three macro balances will satisfy the identity: private savings + government savings + foreign savings $\equiv$ aggregate investment. The modeler must take care not to specify independent equations determining all of these components endogenously, because the resulting model will either not satisfy Walras' Law or be infeasible.

Equations 44 through 46 describe equilibrium conditions for the government deficit, balance of trade, and savings-investment balance. These can be seen as defining notions of macroeconomic equilibrium. Additional equations are required to define the equilibrating variables. Table 6 lists the conditions required, plus a few additional restrictions arising from the definition of traded sectors.

In this model, the government deficit is determined residually in equation 44. Equations 50 to 52 in table 6 fix government expenditure items, and GOVSAV is the equilibrating variable. The second macro equilibrium condition, equation 45, concerns the balance of trade equation. In the model as presented, equations 47 to 49 fix all the financing items in the trade balance equation: net foreign savings, remittances, and net official borrowing (FSAV, REMIT, and FBOR). The result is that the balance of trade in goods and services is set exogenously in the model.[19] The equilibrating variable is the nominal exchange rate, EXR. The equilibrating mechanism at work is that, given the numeraire in equation 53, changes in EXR change the relative prices of nontradables (PD) and tradables (PE and PM)--the real exchange rate.

The CGE model determines an equilibrium relationship between the exchange rate and the balance of trade. For example, an increase in EXR implies a real depreciation, with the sectoral prices of tradables (PE and PM) rising relative to PD. Given the export supply and import demand equations, a real depreciation should lead to higher exports and lower imports. An alternative closure

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[18]In the GAMS program, a variable can be effectively dropped by fixing its value to one.

[19]Note that since the model is based on the GNP accounts, trade in services includes factor services. Thus, the trade balance in this model is the current account balance. Many CGE models are based on the gross domestic product (GDP) accounts, with the balance of trade referring to goods and nonfactor services.

Table 6--Macro closure equations

Balance of trade:

(47) 1   FSAV   = fsav
(48) 1   REMIT   = remit
(49) 1   FBOR   = fbor

Government balance:

(50) 1   GDTOT   = gdtot
(51) 1   GENT   = gent
(52) 1   HHT   = hht

Numeraire price index:

(53) 1   PINDEX   = pindex

Nontraded sectors and sectors with fixed export prices:.

(54) imn   PM(imn)   = 0
(55) imn   M(imn)   = 0

(56) ien   PE(ien)   = 0
(57) ien   E(ien)   = 0

(58) iedn   PWE(iedn) = pwe(iedn)

would be to fix the value of EXR (relative to the numeraire price index). The balance of trade would then be determined endogenously and one of the financing items (FSAV, REMIT, or FBOR) would have to be made into an endogenous variable.

The final macro closure condition (equation 46) requires that aggregate savings equals aggregate investment. Government revenue is determined by the various fixed tax parameters, and government saving (GOVSAV), as mentioned earlier, is determined residually in equation 44. Private savings are determined by various fixed institutional and household savings rates. Foreign saving is also fixed exogenously. The net effect is to specify a savings-driven model in which aggregate investment is determined by aggregate savings. This specification is called "neoclassical closure" in the CGE literature. Most of the U.S. applications of CGE models use some form of neoclassical closure. There are many alternative ways to achieve savings-investment equilibrium in the model, reflecting different theoretical perspectives on how the macro economy operates.[20]

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[20]There is extensive literature on alternative macro closures of CGE models. See Robinson (1989a,b), Rattso (1982), and Dewatripont and Michel (1987). The seminal article is Sen (1963).

In a standard general equilibrium model, the system can only determine relative prices. The choice of numeraire (equation 53) should thus have no effect on the solution value of any real variables. As written, however, the real side of the CGE model is not homogeneous of degree zero in prices. That is, for example, doubling the numeraire price index (PINDEX) would not lead to a new solution with all real variables unchanged and all prices (including the exchange rate) doubled. The problem is that certain variables have been fixed exogenously in nominal terms: government transfers to enterprises and households, GENT and HHT. Unless these items are changed proportionately with any change in the numeraire price index, the real value of the transfers will change. Note that the foreign saving items (FSAV, REMIT, and FBOR) are not a problem, since they are fixed in foreign currency. Their value in domestic currency will change with the exchange rate, which will vary with the numeraire price index.

Counting Equations and Variables

The CGE model can be seen as a set of simultaneous nonlinear equations. Most such models are well-behaved neoclassical general equilibrium models that satisfy the conditions for existence proofs and will thus have at least one solution. In theory, models with many consumers (a typical formulation in applied CGE models) may have multiple equilibrium solutions. In practice, modelers have not found multiple equilibria, so the possibility is evidently more a problem for theorists than practitioners. See Kehoe (1985) and Mas Colell (1985) for discussions of the theoretical issues.

While generally neither necessary nor sufficient to ensure the existence of a solution, it is nonetheless reassuring to check that the number of endogenous variables equals the number of independent equations. Careful counting, set out below, indicates that the number of equations, including those that fix some variables exogenously, is one more than the number of endogenous variables.[21] The CGE model, however, satisfies Walras' Law and the equations defining the equilibrium conditions are not all independent. Any one of them can be dropped, thus equating the number of variables and equations. In the GAMS model, we drop equation 46, the savings-investment equilibrium condition. A test of the model solution is to compute aggregate savings and investment and check to see that they are equal, even though the equation is not explicitly included in the system that is solved.

Table 7 provides a count of equations and variables for the 10-sector U.S. model listed in Appendix 2. The number of variables and equations for each block is counted using the set indexes; i, f, ins, hh. For this model, the index values are: i = 10, f = 3,

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[21]Equations 54 to 58 are included to account for sectors in which there are no exports or imports, or for which there are no export demand functions.

Table 7--Count of equations and variables

Variables:

Price block:	$(8 \cdot i) + 2$	=	82
Quantity block:	$(6 \cdot i) + (f \cdot i) + 3$	=	93
Income block:	$(5 \cdot i) + f + ins + hh + 22$	=	81

Total: $(19 \cdot i) + (f \cdot i) + f + ins + hh + 27$ = 256

Equations:

Price block:	$im + ie + (4 \cdot i) + 1$	=	60
Quantity block:	$(2 \cdot i) + (f \cdot i) + (2 \cdot ie) + ien$		
	$+ ied + (2 \cdot im) + imn$	=	92
Income block:	$f + hh + 14$	=	20
Expenditure block:	$(5 \cdot i) + 3$	=	53
Market clearing block:	$i + f + 3$	=	16
Macro closure:	7	=	7
Nontraded sectors:	$(2 \cdot imn) + (2 \cdot ien) + iedn$	=	9

Total: $(12 \cdot i) + (f \cdot i) + (3 \cdot im) + (3 \cdot ie) + ied +$
$(3 \cdot imn) + (3 \cdot ien) + iedn + (2 \cdot f) + hh + 28$ = 257

$ins = 3$, and $hh = 3$. The subsets of "i" for the model are: $im = 9$, $ie = 10$, $ied = 3$, $imn = 1$, $ien = 0$, and $iedn = 7$. There are 256 variables and 257 equations, one more equation than endogenous variables. However, as discussed above, the equations are not all independent and one of the equilibrium conditions can be dropped. Typically, the savings-investment or balance-of-trade equilibrium condition, equation 46 or 45, is dropped. In our model, we drop the savings-investment equation.[22]

Calibration of Model Parameters

In this section, we describe how base year data are used to calibrate model parameters. We calibrate parameters from a 1982 Social Accounting Matrix (SAM) data base plus additional estimated parameters such as values of various elasticities. The

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[22]Adelman and Robinson (1978) and Dervis, de Melo, and Robinson (1982) typically dropped the excess-demand equation for the largest sector. Condon, Dahl, and Devarajan (1987) dropped the balance-of-trade equation. A symmetric approach is to define an additional endogenous variable equal to the difference between aggregate savings and investment and leave in the redundant equation. The additional variable must equal zero at the equilibrium solution.

base year model solution, given the calibrated parameters, should reproduce the base year SAM. Making sure the solution SAM is consistent with the input data SAM is a useful consistency check of the model equations, SAM data base, and calibrated parameters.

The data on the U.S. economy are organized into a SAM. Construction of the SAM is a major task in itself.[23] The development of the 1982 SAM for the United States is discussed in Hanson and Robinson (1989). In figure 2, we present an aggregated 1982 SAM which is consistent with the U.S. National Income and Product Accounts (NIPA).

The disaggregated SAM combines the input-output tables with the NIPA. The U.S. input-output tables are produced every 5 years. The last published table is for 1977. See U.S. Department of Commerce, Bureau of Economic Analysis (1984). The input-output table was updated to 1982 under a contract with the U.S. Forest Service.[24] With some further adjustments, this updated table provides the core data set for our model. In addition to the data in the NIPA and input-output tables, the data base for a CGE model includes quantity measures for factors of production, a capital composition matrix, and various elasticities.

Common practice in calibrating CGE models is to assume that the base year of the model is also the base year for price indices. Units are defined so that all prices equal one, and the sectoral flows in the SAM measure both real and nominal magnitudes. The initial goods market equilibrium between supply and demand is thus obtained at prices equal to one. Such choice of units simplifies the calibration procedure, although it is not required.[25]

In calibration, the model equations are solved in reverse. Given base-year values for the variables, the parameters are derived from the equations. Calibration is a mathematical, not a statistical, procedure. We describe the calibration procedure for some of the parameters, following the equation blocks above.

Production and Trade Aggregation Functions

For the quantity equation block, equations 8-17, we need to calibrate the parameters of the Cobb-Douglas production function, the CES aggregation function for imports and domestic goods, and

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[23]The data organization and reconciliation were facilitated by using a Fortran program call the "SAM Generator." The structure of the program is described in an appendix to Dervis, de Melo, and Robinson (1982).

[24]The work was done by a consulting firm called Engineering Economics Associates of Berkeley, California. When the official U.S. input-output tables for 1982 become available, we will update the 1982 SAM data base.

[25]In recent work with the USDA/ERS CGE model, we have rebased the model on a 1986 SAM with real magnitudes defined in terms of 1982 prices.

Figure 2--A SAM for the United States in 1982

	Billions of dollars	1 Suppliers Commodity	2 Suppliers Activity	3 Value added Labor	4 Value added Capital	5 Enterprise	6 Household	7 Government	8 Capital	9 World	Row totals
	Suppliers										
R E C E I P T S	1 Commodity		2,808.9				2,050.7	641.7	447.3		5,948.6
	2 Activity	5,604.4						0.0		361.9	5,966.3
	Value added										
O R	3 Labor		1,907.0								1,907.0
	4 Capital		1,000.2								1,000.2
I N C O M E	**Institutional actors**										
	5 Enterprise				1,000.2			47.5			1,047.8
	6 Household			1,637.5		581.6		396.2		-1.2	2,614.0
	7 Government	8.6	250.2	269.5		63.1	409.3			-26.1	974.6
	8 Capital					403.1	154.0	-110.8		1.0	447.3
	9 World	335.6									335.6
	Column totals	5,948.6	5,966.3	1,907.0	1,000.2	1,047.8	2,614.0	974.6	447.3	335.6	

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the CET transformation function for exports and domestic sales. In each, we choose elasticity values from econometric estimates available in the literature. Given these elasticities, the shift and share parameters can be calibrated from the base year data.

The Cobb-Douglas production function, equation 8, has four parameters: the three factor-share parameters and the shift parameter. The SAM data include production, XD(i), factor demand, FDSC(i,f), and factor income, FCTRY(i,f), all by sector. From factor demand by sector and factor income by sector the average factor price WF(f) and the factor price sectoral proportionality constants, wfdist(i,f), are calculated. In the next part of this section, we go into more detail on the factor price calculations.

The value-added price, PVA(i), also goes into the calculation of the production function parameters. This price depends on the producer price, the cost of intermediate goods, and the indirect business tax. Note that production and factor demand account for market distortions, because the distortions are captured in the wfdist parameters and in the value-added prices:

PVA(i) = PX(i)*(1 - itax(i)) - SUM(j, io(j,i)*P(j))

which include <u>ad valorem</u> distorting taxes, itax(i). Any other <u>ad valorem</u> tax or subsidy instruments can either be added to the model in the value-added price equation or included in the itax parameters.

The first order conditions for profit maximization, equation 9, define the factor demand equations. From equation 9, solve for the share parameters, alpha(i,f):

alpha(i,f) = wfdist(i,f)*WF(f)*FDSC(i,f)/(PVA(i)*XD(i))

Given that the data from the SAM add up, total factor payments must equal total value added in each sector. The effect is to assume constant returns to scale in production, so that the SUM(f, alpha(i,f)) will equal one in all sectors.

Once the factor shares are determined, the shift parameter of the Cobb-Douglas production function remains to be calibrated. Given the data on total output XD(i), factor employment FDSC(i,if), and the calibrated alpha(i,if), the ad(i) parameters are given by (from equation 8):

ad(i) = XD(i)/PROD(f, FDSC(i,f)**alpha(i,f))

Calibration of the CES and CET trade aggregation functions is very similar to the treatment of the production functions. The CES and CET functions are characterized by a non-unitary elasticity of substitution or transformation, share parameters (which sum to one), and a shift term. The various model equations do not suffice to identify all these: one parameter must be determined outside the model. Standard practice is to

use outside econometric estimates of the elasticity of substitution or transformation.[26]

For the CES function, the elasticity of substitution measures the degree to which imported and domestic versions of the "same" good can be substituted for each other. In the model, the rhoc(i) parameter equals (1/elasticity - 1). An analogous relationship holds for the rhot(i) parameter in the CET function.[27]

Given these elasticities, the import demand and export supply equations can be used to solve for the share parameters in the CES and CET function. From equation 17, the import demand equation, the delta parameters can be computed in two steps (with delta1 as an intermediate calculation):

delta1(im) = (PM(im)/PD(im))*(M(im)/XXD(im))**(1 + rhoc(im))
delta(im) = delta1(im)/(1 + delta1(im))

Finally, the shift parameters are calculated from equation 15:

ac(im) = X(im)/[delta(im)*M(im)**(-rhoc(im))
         + (1 - delta(im))*XXD(im)**(-rhoc(im))]**(-1/rhoc(im))

The computation for the export supply function is similar.

Factor Price Sectoral Proportionality Constants

The parameters wfdist(i,f) relate sector-specific factor returns to the economywide average factor return, WF(f). The SAM includes data on factor payments by factor and sector. Coupled with data on the number of units of factors (workers, capital stock, and acres of land), both the sector-specific and economywide average factor returns can be calculated. For example, the sector-specific wage equals a sector's "wage bill" divided by the number of workers in the sector. The average wage is the economywide wage bill divided by the total number employed. Wfdist(i,"labor") for a sector is the ratio of the sector-specific to the average wage.

Gross capital returns by sector can be determined residually given data on value added, wages, and land rental. Given estimates of sectoral capital stocks, sectoral capital rental rates and the wfdist(i,"capital") parameters can be computed in the same manner as the parameters for labor.[28] An alternative approach used by Ballard, Fullerton, Shoven, and Whalley (1985) is to start with calculated wfdist parameters. They assume that the only reason capital rentals differ across sectors is

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[26]For the United States, substitution elasticities for imports have been estimated by Shiells, Stern, and Deardorff (1986), and more recently, by Reinert and Roland-Holst (1990).
[27]In the GAMS program, the parameters are read in as elasticities and the rhoc and rhot parameters are computed.
[28]We use capital-stock data from the U.S. Department of Commerce, Bureau of Economic Analysis (1987).

variation in tax rates. Given data on sectoral taxes, they estimate the wfdist parameter for capital in each sector. Assuming that after-tax rental rates must be equal across sectors, they then use an estimate of the economywide rental rate to compute sectoral capital stocks.

The wfdist(i,f) parameters reflect: (1) distortions in the factor markets such as impediments to factor mobility among sectors or differential tax rates, and/or (2) aggregation errors in the definition of factors. Examples of the second effect might be variations in capital vintages across sectors that are not captured in capital stock data or variations in the occupation, skill, or education composition of the labor force across sectors. The general equilibrium model assumes that the return to a given factor would be equal across sectors if the factors were indeed homogeneous and there were no rigidities or distortions.

The fact that there are rigidities and distortions is reflected in that the measured wfdist(i,f) parameters differ from one. By assuming these parameters to be constant across experiments, the modeler assumes that the structural characteristics responsible for the differentials are invariant to the question at hand. That is, all policy experiments must be seen as comparing second-best situations, given existing factor-market distortions. Indeed, the existence of such distortions is a strong argument for using CGE models, since welfare comparisons in second-best situations are usually theoretically ambiguous, with results depending on parameter values. Of course, it is possible to do experiments in which the wfdist parameters are changed, which is the approach taken in much of the public finance literature using CGE models.[29]

Tax and Saving Rates in the Income Equations

The parameters in the income equations include the institutional tax and saving rates as well as household tax and saving rates. The SAM data provide the values of total institutional and household income and the amounts saved and paid in taxes. The average tax and saving rates are simply calculated as the ratios of taxes or savings to the income base.

The institutional structure of the model depends on the household aggregation. For the types of households in the basic model, we distinguish institutions by their functional source of income. Institutional income is factor income net of institutional taxes and savings, and includes government transfers. The net income of the labor institution is labor income net of social security taxes.

The net income of the enterprise institution is the capital income of producers, net of the profit tax on enterprise income, retained earnings which goes to the capital account, and

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[29]For a survey of tax models, see Shoven and Whalley (1984).

depreciation which also goes to the capital account. Note that depreciation equals the depreciation rate depr(i) times the value of productive capital valued at replacement cost, an economic rather than a tax definition. The enterprise institution also receives business transfer payments from the government. The property institution receives the factor income for land.

Net institutional income is apportioned to households using fixed share parameters, sintyh(hh,ins), which represent shares of each type of institutional income received by the different household categories. For these parameters, the sum over households equals one for all institutions. The USDA/ERS CGE model can distinguish households in either of two ways: (1) according to income class (such as lower 40th percentile, mid-40th percentile, and upper 20th percentile); or (2) according to function or income source, such as workers, capitalists (or rentiers), and transfer recipients.[30] The model presented in Appendix 2 follows the functional household definition. For example, if only worker households earn the economy's labor income, the share to worker households is one, that is sintyh(worker,labor) = 1; while for nonworker households it is zero. All distributed profits and property income go to rentier households.

Household income is taxed, saved, or spent on consumer goods and services. The income received by households includes remittances from abroad, transfers from the government, and factor income. Household income tax payments are computed as an average tax rate times gross income, which includes transfer income and remittances from abroad (or net of remittances sent out of the country). The average tax rate, htax(hh), for each household type is calibrated from the income flows and taxes paid in the base year. Household average savings rates, mps(hh), are determined as the ratio of household savings to income net of taxes. Household remittances from abroad, REMIT, are exogenous variables denominated in foreign currency. Consequently, they are multiplied by the exchange rate to determine domestic income flows. Household remittance shares, rhsh(hh), are computed from base-year data.

Sectoral Composition of Expenditures

There are a number of parameters that determine the sectoral composition of various categories of demand. These categories include: (1) demand for intermediate inputs, io(i,j); (2) composition of capital goods, imat(i,j); (3) household average expenditure shares, cles(i,hh); (4) investment allocation by sector of destination, kish(i); and (5) government demand shares, gles(i). All these parameters are computed from base-year data.

Intermediate goods are demanded in fixed proportions, using input-output coefficients io(i,j) defined in real terms (that is,

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[30]Adelman and Robinson (1988) and Robinson, Kilkenny, and Adelman (1989) categorize households by income class. Hanson, Robinson, and Tokarick (1990) categorize by income source.

units of input per unit output). Note that intermediate demand is for the composite good. The elements of the capital composition matrix, imat(i,j), are also defined in real terms as units of composite good i required per unit of capital in sector j.[31] While these coefficients are fixed, the import shares are not because they are a function of relative prices (given the sectoral import aggregation functions).

The demand by household hh for good i depends on the cles(i,hh) parameters, which represent expenditure shares--the fraction of household hh's total nominal expenditure that is spent on good i. The different expenditure shares across household type are estimated from data on expenditure shares by income class. The government sectoral expenditure shares, gles(i), are defined in real terms since total government expenditure (GDTOT) is defined as a real magnitude. These shares are taken from the input-output table. Finally, the allocation of total nominal investment by sector of destination, the kish(i) parameters, are based on data from U.S. Department of Commerce, Bureau of Economic Analysis (1987).

Implementing the CGE Model in GAMS

Table 8 presents an outline of a CGE model programmed in GAMS. For those familiar with GAMS, the outline uses terms describing a typical GAMS program. See the GAMS manual by Brooke, Kendrick, and Meeraus (1988). The model listing in Appendix 2 follows this outline.

A GAMS program typically starts with statements that define "sets" used in the model. In the CGE model, these sets define the various indices for subscripted variables and parameters. We distinguish sets for production sectors, factors of production, institutions, and households.

Second, we declare and define the various parameters in the model. In the CGE model, there are three kinds of parameters. First, the entire base-year SAM is read in. Second, parameters that are estimated outside the model, such as various elasticities, are read in. Third, based on the read-in data and parameters, the remaining parameters are computed, completing the calibration process.

Third, the endogenous variables in the model are declared and defined. The solution procedure also requires that all endogenous variables be given an initial value to start the algorithm. In programming models, if initial values are not specified, most algorithms try a guess of zero. For a CGE model, where the solution is expected to yield strictly positive prices and quantities, such a guess would often lead to singularities

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[31]The capital composition matrix is derived from the capital flows table published by the U.S. Department of Commerce, Bureau of Economic Analysis (1985).

Table 8--Structure of a GAMS CGE model

1) Sets
      a) specified sets
      b) subsets

2) Parameters
      a) parameter declaration
          i) exogenous parameters
          ii) calibrated parameters
      b) parameter assignment
          i) enter data
          ii) assign exogenous parameters
          iii) calibrate parameters

3) Variables
      a) variable declaration
      b) variable initialization

4) Display input Social Accounting Matrix (SAM)

5) Equations
      a) equation declaration
      b) equation assignment
          i) model equations
          ii) model closure and variable restrictions

6) Model definition and solve command

7) Calculate and display result tables

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or, at best, nasty scaling problems. It is important to provide guesses as close as possible to the expected solution. We use the base-year SAM to initialize all endogenous variables.

Fourth, the base-year SAM from calibrated parameters is displayed. This SAM should replicate the initial data before the model is solved, and provides a check on the data input, parameter calibration, and initialization of endogenous variables. If the calibration procedure is done correctly, the solution of the CGE model in the base year should replicate the initial SAM (within acceptable rounding error). Printing the pre-solution and post-solution SAM's facilitates debugging the calibration process.

Fifth, the equations of the model are declared and defined. The GAMS program follows closely the presentation of equations above. Then, sixth, the model is defined and solved. The equations that are to be included in the CGE model are listed. Next, there is a SOLVE statement that calls a solution algorithm, such as NLP for nonlinear programming, to solve the model.

Finally, after the SOLVE statement is executed, GAMS has solution values for all endogenous variables. It remains only to print them. This is done in part seven. GAMS has standard defaults

for printing solution reports. We turn off the default solution printing and generate our own output tables.

After a base-year or "benchmark" solution is created, the CGE model will typically be used to run counterfactual, comparative static, experiments. A parameter or exogenous variable is changed and the model is solved again. Given the structure of the GAMS program, it is important to make such changes after the initialization of parameters, but before the model SOLVE statement. A common error is to change some input data in the parameter assignment part of the program. What happens in this case is that all the calibrated parameters are changed to be consistent with the changed input data, completely changing the model. The result is not a comparative statics experiment, but a comparison of two different models that may, depending on the nature of the changed parameters, have the same SAM. We have found it convenient to do experiments using the SAVE and RESTART commands in GAMS. In this procedure, the base solution is saved and a new experiment file is created that includes the model changes, solve statement, and display statements for tables of results. Experiment results are generated by using the RESTART option when running the experiment GAMS program.

Applications, Variations, and Extensions

In this section, we discuss how the USDA/ERS CGE model has been used. The model is very close to the Walrasian, neoclassical paradigm. In most applications, it is necessary to make changes in the institutional and behavioral assumptions in order to have the model better reflect the workings of an actual economy. We will discuss some changes that have been used in the USDA/ERS model to analyze policy issues relating to agriculture and international trade.[32]

Comparative Statics and Dynamics

The CGE model described here represents a single period equilibrium. None of the arguments in the various equations involve lagged variables or expected future variables, so the model is really timeless. It determines a flow equilibrium based on signals for the current period only. A given benchmark solution does, however, reflect initial conditions and past circumstances captured in the base-year data set.

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[32]We make no attempt to provide a general survey of applications of CGE models. See Robinson (1989b) for a survey of applications to developing countries, Robinson (1990) and Hertel (1990) for surveys of agriculture-focused models, de Melo (1988) for a survey of recent trade-focused CGE models, Shoven and Whalley (1984) for an earlier review of models on taxation and trade, and Powell and Lawson (1986) for a review of policy modeling with the Australian ORANI model.

The most common use of CGE models is to do comparative statics experiments. The interpretation of the results involves a very simple notion of time: "long enough" for all specified equilibrium conditions to be satisfied. Whether that period is short, medium, or long run depends on assumptions about elasticities and factor mobility in the model. For example, the basic model assumes all factors are mobile, a longrun assumption.

Since the first applications of CGE models to developing countries, the models have been made dynamic by solving for a sequence of time-recursive solutions. Time-dependent variables (such as the aggregate capital stock, labor force, and total factor productivity) are "updated" between periods. These dated variables are assumed exogenous within periods. Time-recursive dynamic paths are generated as a sequence of static CGE models linked by an intertemporal model that updates dated variables.[33]

We have used this approach with the USDA/ERS model. Adelman and Robinson (1988) analyzed the 1981 to 1985 period. Robinson, Kilkenny, and Adelman (1989) used forward projections from 1986 to 1991. Hanson, Robinson, and Tokarick (1990) project from 1988 to 1991 and 1995. In the last two applications, the CGE model is loosely linked to econometric macroeconomic projection models which provide estimates of real GNP growth, foreign prices, the government deficit, the balance of trade, and the aggregate price level. Robinson, Kilkenny, and Adelman used the "Trend Growth Model" (TGM), which is described in Monaco (1987). Hanson, Robinson, and Tokarick use results from a world econometric model developed in the ERS by Malley (1990). The macro models provide a logical framework for modeling intertemporal linkages and nicely complement the within-period CGE model.[34]

Adelman and Robinson (1978) describe this approach to dynamics as "lurching equilibrium" and it captures many elements of "adaptive" dynamic models and "temporary equilibrium" macro models.[35] This approach to dynamics has been criticized by Bell and Srinivasan (1984) who argue that the models are not forward looking and hence are not "truly" dynamic. There are a few examples of forward-looking dynamic CGE models, ranging from two-period to longrun multiperiod models, but they are quite stylized.[36] Bell and Srinivasan also note that dynamic equilibrium models can only be used to generate steady-state solutions, and that such solutions are usually not very

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[33]This is the technique first used by Adelman and Robinson (1978). It has later been used in applications to developing countries. See Dervis, de Melo, and Robinson (1982).

[34]This approach to linking CGE and macro models is described in Robinson and Tyson (1984) and has also been used in Australia. See Cooper, McLaren, and Powell (1985).

[35]See Day and Cigno (1978) for examples of adaptive dynamic models.

[36]See Dervis (1975), Goulder and Eichengreen (1989), Goulder and Summers (1989), Jorgenson and Wilcoxen (1989), and Pereira and Shoven (1988).

realistic. Since applied models build on existing theory, not advance it, future advances in applied dynamic models will require further theoretical developments. Parsell, Powell, and Wilcoxen (1989) discuss some recent developments in reconciling applied general equilibrium models with dynamic macroeconomics.

Factor Markets

In the basic model, all primary factors of production are perfectly mobile. Given the fixed total supplies of primary factors, economywide average factor prices adjust to maintain full employment equilibrium. An alternative widely used in models of developing countries is to assume the sectoral employment of a primary factor such as capital is fixed. The underlying story is that the model incorporates a shortrun adjustment period in which capital is assumed immobile.

Fixing factor employment by sector amounts to adding equations to the system, so an equal number of endogenous equilibrating variables must be included. With sectoral capital stocks fixed, one must assume that sectoral rental rates will vary. This specification is easily accommodated in the CGE model by redefining the wfdist(i,f) parameters as variables and fixing the average factor price variable to one. Kilkenny and Robinson (1988, 1990) use this specification to explore the effect of policy changes under different assumptions about factor mobility.

Another common factor market assumption is to assume that the wage is not flexible. With a fixed wage, the labor market is assumed to be rationed. The standard assumption is that producers hire as much labor as they wish at the fixed wage and that suppliers are rationed; that is, there is involuntary unemployment. This specification is easily accommodated in the CGE model by specifying the wage as an exogenous variable and aggregate labor supply as endogenous. This option is noted with comments in the GAMS listing in Appendix 2.

Modeling Agricultural Programs

The USDA/ERS model was developed to analyze the impact on the economy of proposed changes in agricultural policies. To date, most of the applications have concerned trade liberalization and have worked with a 10-sector version of the model.[37] The standard approach to modeling agricultural programs has been to measure their total cost and use an equivalent fixed <u>ad valorem</u> subsidy in the model.[38] In the CGE model, this approach would be implemented by creating a subsidy parameter that would enter the model as a negative indirect tax. Everywhere the parameter itax(i) appears, there would be an additional subsidy parameter.

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[37]See Robinson, Kilkenny, and Adelman (1989).

[38]These subsidy rates, called producer subsidy equivalents or PSE's, have been computed for a number of countries. The data are reported in U.S. Department of Agriculture, Economic Research Service (1988).

Kilkenny and Robinson (1988, 1990) argue that using ad valorem equivalents is not an adequate approach to modeling the complex mix of agricultural policies in the United States. They have extended the basic CGE model to include an explicit modeling of the different government programs affecting U.S. agriculture, including import rationing, export subsidies, deficiency payments, and government stocking. Their empirical results indicate that explicit modeling of the programs is especially important when estimating changes in the cost of government programs under different macro and policy scenarios, as well as for welfare analysis and analysis of the effect on linked sectors of policy changes.

The explicit modeling of agricultural programs is, of necessity, fairly stylized in the context of a 10-sector model with only 3 agricultural sectors. The basic model has recently been expanded to include 30 sectors in order to provide a better framework for such analysis.[39] This expanded model should provide a richer framework for analyzing trade liberalization scenarios and proposed policy changes being discussed in the context of the 1990 farm bill.

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[39]Kilkenny (1990) describes how agricultural programs are modeled in the new 30-sector model.

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Appendix 1: Model Summary

This appendix brings together all the model equations, including the list of variable and parameter definitions. Endogenous variables are in upper case and parameters are in lower case. To treat a variable as exogenous, we add the suffix ".FX" (which means "fixed"). The suffix ".L" means "level" and refers to the value of a variable. These suffixes follow the GAMS language. In GAMS, before the model is solved, the .L suffix denotes an initial guess. After solution, it denotes the solution value.

Indices are also in lower case, but are always given in parentheses. In some equations, the index is replaced by a specific entry, given in quotes. As noted earlier, the words SUM and PROD denote the summation and product operators over the index given after the left parenthesis (Σ and Π).

Indices

i, j	Sectors
im	Sectors with imports
imn	Sectors without imports: im + imn = i
ie	Sectors with exports
ien	Sectors without exports: ie + ien = i
ied	Sectors with world export demand functions
iedn	Sectors with fixed world export prices: ied + iedn = ie
f	Factors of production: "labor," "capital," and "land"
ins	Institutions: "labr," labor; "ent," enterprises; "prop," proprietors
hh	Household types

Parameters

ac(im)	CES function shift parameter
ad(i)	Production function shift parameter
alpha(i,f)	Share parameter in production function
at(ie)	CET function shift parameter
cles(i,hh)	Household expenditure shares
delta(im)	CES function share parameter
depr(i)	Depreciation rate
dstr(i)	Ratio of inventory investment to domestic output
econst(ied)	Export demand function shift parameter
esr	Enterprise saving rate
etr	Enterprise tax rate
fs(f)	Aggregate factor supply
gamma(ie)	CET function share parameter
gles(i)	Government expenditure shares
htax(hh)	Household income tax rate
imat(i,j)	Capital composition matrix
io(i,j)	Input-output coefficients
itax(i)	Indirect business tax rate
kish(i)	Shares of investment by sector of destination
mps(hh)	Household saving rate
pwm(im)	World price of imports
pwse(ied)	World price of export substitutes
rhoc(im)	CES function exponent

rhot(ie)	CET function exponent
rhsh(hh)	Household remittance share
sintyh(hh,ins)	Household distribution of institutional income
sstr	Social security tax rate
tm(im)	Tariff rate on imports
tmreal(im)	Real tariff rate
te(ie)	Export subsidy rates
tereal(ie)	Real export subsidy rate
thsh(hh)	Household share of government transfers
wfdist(i,f)	Factor market distortion parameters

Variables

Prices Block

EXR	Exchange rate
P(i)	Price of composite good
PD(i)	Domestic sales price
PE(i)	Domestic price of exports
PINDEX	GNP deflator
PK(i)	Price of a unit of capital in each sector
PM(i)	Domestic price of imports
PVA(i)	Value added price
PWE(i)	World price of exports
PX(i)	Output price

Production Block

E(i)	Exports
FDSC(i,f)	Factor demand
INT(i)	Intermediate input demand
M(i)	Imports
WF(f)	Average factor price
X(i)	Composite goods supply
XD(i)	Domestic output
XXD(i)	Domestic sales

Income and Expenditure Blocks

CD(i)	Final demand for private consumption
DEPRECIA	Total depreciation charges
DK(i)	Fixed Investment by sector of destination
DST(i)	Inventory investment by sector
ENTSAV	Enterprise savings
ENTTAX	Enterprise tax revenue
FBOR	Net foreign borrowing
FXDINV	Fixed capital investment
FSAV	Foreign savings
GD(i)	Final demand for government consumption
GDTOT	Aggregate real government consumption
GENT	Transfer payments from government to enterprises
GNPVA	Nominal GNP or value added in market prices
GOVSAV	Government savings
GR	Total government revenue
HHSAV	Total household savings
HHT	Government transfer payments to households

ID(i)	Final demand for investment goods
INDTAX	Total indirect tax revenue
INVEST	Total investment
NETSUB	Total export subsidies
REMIT	Net remittances from abroad
RGNP	Real GNP
SAVINGS	Total savings
SSTAX	Social security tax revenue
TARIFF	Tariff revenue
TOTHHTAX	Household tax revenue
YFCTR(f)	Factor income
YH(hh)	Household income
YINST(ins)	Institutional income

Equations

Prices

(1) im $\quad$ $PM(im) = pwm(im)*(1 + tm(im))*EXR$

(2) ie $\quad$ $PE(ie) = PWE(ie)*(1 + te(ie))*EXR$

(3) i $\quad$ $P(i) = (PD(i)*XXD(i) + PM(i)*M(i))/X(i)$

(4) i $\quad$ $PX(i) = (PD(i)*XXD(i) + PE(i)*E(i))/XD(i)$

(5) i $\quad$ $PVA(i) = PX(i)*(1 - itax(i)) - SUM(j,io(j,i)*P(j))$

(6) i $\quad$ $PK(i) = SUM(j, P(J)*imat(j,i))$

(7) 1 $\quad$ $PINDEX = GNPVA/RGNP$

Production

(8) i $\quad$ $XD(i) = ad(i)*PROD(f, FDSC(i,f)**alpha(i,f))$

(9) i,f $\quad$ $WF(f)*wfdist(i,f) = PVA(i)*alpha(i,f)*XD(i)/FDSC(i,f)$

(10) i $\quad$ $INT(i) = SUM(j, io(i,j)*XD(j))$

(11) ie $\quad$ $XD(ie) = at(ie)*(gamma(ie)*E(ie)**rhot(ie)$
$+ (1 - gamma(ie))*XXD(ie)**rhot(ie))**(1/rhot(ie))$

(12) ien $\quad$ $XD(ien) = XXD(ien)$

(13) ie $\quad$ $E(ie) = XXD(ie)*(PE(ie)/PD(ie)*(1 - gamma(ie))/$
$gamma(ie))**(1/(rhot(ie)-1))$

(14) ied $\quad$ $E(ied) = econst(ied)*((PWE(ied)/pwse(ied))**(-rhoe(ied)))$

(15) im $\quad$ $X(im) = ac(im)*(delta(im)*M(im)**(-rhoc(im)) +$
$(1-delta(im))*XXD(im)**(-rhoc(im)))**(-1/rhoc(im))$

(16) imn $\quad$ $X(imn) = XXD(imn)$

(17) im $\quad$ $M(im) = XXD(im)*((PD(im)/PM(im))*(delta(im)/$
$(1 - delta(im))))**(1/(1 + rhoc(im)))$

Income Generation

(18) f $\quad$ $YFCTR(f) = SUM(i, WF(f)*wfdist(i,f)*FDSC(i,f))$

(19) 1 $\quad$ $YINST("labr") = YFCTR("labor") - SSTAX$

(20) 1 $\quad$ $YINST("prop") = YFCTR("land")$

(21) 1 $\quad$ $YINST("ent") = YFCTR("capital") + GENT - ENTSAV - ENTTAX$
$- DEPRECIA$

(22) hh $\quad$ $YH(hh) = SUM(ins, sintyh(hh,ins)*YINST(ins))$
$+ rhsh(hh)*REMIT*EXR + thsh(hh)*HHT$

(23) 1 $\quad$ $TARIFF = SUM(im, tm(im)*pwm(im)*M(im))*EXR$

(24) 1 $\quad$ $INDTAX = SUM(i, itax(i)*PX(i)*XD(i))$

(25) 1 $\quad$ $NETSUB = SUM(ie, te(ie)*PWE(ie)*E(ie))*EXR$

(26) 1 $\quad$ $SSTAX = sstr*YFCTR("labor")$

```
(27) 1    ENTTAX    = etr*(YFCTR("capital") - DEPRECIA + GENT)
(28) 1    TOTHHTAX  = SUM(hh, htax(hh)*YH(hh))
(29) 1    DEPRECIA  = SUM(i, depr(i)*PK(i)*FDSC(i,"capital"))
(30) 1    ENTSAV    = ESR*(YFCTR("capital") + GENT - ENTTAX - DEPRECIA)
(31) 1    HHSAV     = SUM(hh, mps(hh)*YH(hh)*(1 - htax(hh)))
(32) 1    GR        = TARIFF - NETSUB + INDTAX + TOTHHTAX + SSTAX
                            + ENTTAX + FBOR*EXR
(33) 1    SAVINGS   = HHSAV + GOVSAV + DEPRECIA + FSAV*EXR + ENTSAV
```

Expenditure

```
(34) i    P(i)*CD(i) = SUM(hh, cles(i,hh)*(1 - mps(hh))*YH(hh)
                              *(1 - htax(hh)))
(35) i    GD(i)      = gles(i)*GDTOT
(36) i    DST(i)     = dstr(i)*XD(i)
(37) 1    FXDINV     = INVEST - SUM(i, DST(i)*P(i))
(38) i    PK(i)*DK(i) = kish(i)*FXDINV
(39) i    ID(i)      = SUM(j, imat(i,j)*DK(j))
(40) 1    GNPVA      = SUM(i, PVA(i)*XD(i)) + INDTAX + TARIFF - NETSUB
(41) 1    RGNP       = SUM(i, CD(i) + DST(i) + ID(i) + GD(i))
                            + SUM(ie, (1 - tereal(ie))*E(ie))
                          - SUM(im, (1 - tmreal(im))*M(im))
```

Equilibrium Conditions

```
(42) i    X(i)            = INT(i) + CD(i) + GD(i) + ID(i) + DST(i)
(43) f    SUM(i, FDSC(i,f)) = fs(f)
(44) 1    GR              = SUM(i, P(i)*GD(i)) + GOVSAV + GENT + HHT
(45) 1    SUM(im, pwm(im)*M(im)) = SUM(ie, PWE(ie)*E(ie))
                              + FSAV + REMIT + FBOR
(46) 1    SAVINGS    = INVEST
```

Macro Closure: Balance of Trade

```
(47) 1    FSAV.FX    = fsav.1
(48) 1    REMIT.FX   = remit.1
(49) 1    FBOR.FX    = fbor.1
```

Macro Closure: Government Balance

```
(50) 1    GDTOT.FX   = gdtot.1
(51) 1    GENT.FX    = gent.1
(52) 1    HHT.FX     = hht.1
```

Numeraire Price Index

```
(53) 1    PINDEX.FX  = pindex.1
```

Nontraded Sectors and Fixed Export Prices

```
(54) imn   PM.FX(imn)  = 0
(55) imn   M.FX(imn)   = 0
(56) ien   PE.FX(ien)  = 0
(57) ien   E.FX(ien)   = 0
(58) iedn  PWE.FX(iedn) = pwe.1(iedn)
```

Appendix 2: GAMS Listing of U.S. CGE Model

This appendix provides a listing of the output from a GAMS execution of the U.S. model for 1982. Some output tables have been omitted to save space.

In solving CGE models, the GAMS program uses software designed to solve nonlinear programming problems. The solver most commonly used is the MINOS program developed at Stanford University, described in Appendix D of Brooke, Kendrick, and Meeraus (1988). The CGE model is treated by MINOS as a special programming problem that happens to have a unique feasible basis. Since there is only one feasible solution that satisfies the constraint equations, it does not matter what the objective function is. In the model listed here, we specify real GNP as the maximand. A good test of whether the model is specified correctly is to solve the problem twice, first maximizing GNP and second minimizing GNP. If the CGE model is properly specified, it will have a unique solution and the two solutions should be the same.

Using a nonlinear programming algorithm to solve a "square" model (that is one with as many constraints as variables) seems a bit wasteful. The algorithm MINOS uses to find a feasible basis, however, appears to provide a very robust approach to solving systems of simultaneous nonlinear equations. In the GAMS implementation of MINOS, it is possible to change parameters determining how MINOS operates so as to greatly improve its performance as an equation solver. The new parameters are specified in a file called MINOS5.OPT which GAMS reads when it starts to solve the problem. The MINOS5.OPT file for solving CGE models is listed below:

```
BEGIN
START ASSIGNED NONLINEARS BASIC
END
```

The details of how to use the MINOS5.OPT file are described in Appendix D.2 of Brooke, Kendrick, and Meeraus (1988). While changing these parameters usually improves the performance of MINOS in solving CGE models, it may make things worse. If the algorithm fails, try again without using the MINOS5.OPT file.

In doing experiments with the GAMS CGE model, save the base solution and use it as a starting point for doing experiments. In GAMS, a solution can be saved and reused using the "SAVE" and "RESTART" options. See the GAMS manual for details. Specifying this option saves the base-year solution as the initial "guess" for another model. The GAMS programs for doing experiments may then be written in a few lines. One need only specify changes in parameters or exogenous variables and add a new SOLVE statement. Following the SOLVE statement, a list of display statements may be copied from the base-year GAMS program to output results. Given that the entire base solution is stored, one can easily generate "ratio to base" tables by renaming the new results tables and computing ratios to the old tables (which contain the saved original base solution).

```
1   $TITLE USDA/ERS GAMS U.S. CGE MODEL FOR 1982
2   $OFFSYMLIST OFFSYMXREF OFFUPPER
3
4   *#### U.S. CGE MODEL WITH 1982 DATA BASE, Billions of Dollars.
5   *USDA/ERS GNP Version, April 1990
6   *Programmed by: Sherman Robinson, Kenneth Hanson, and Maureen Kilkenny.
7   *
8   *The model is based on GNP data, and includes exports and imports of
9   *factor services.
10
11  *##################### SET DECLARATION #########################
12
13   SETS
14
15   I       SECTORS              / lvstk      dairy and meat
16                                  expcrp     grains and oilseeds
17                                  othcrp     other agriculture
18                                  agproc     agric processing
19                                  aginp      agric inputs
20                                  intmnf     interm manuf
21                                  fdmnf      final demand manuf
22                                  trdtrn     trade and transport
23                                  service    services
24                                  resta      real estate /
25
26   F       FACTORS OF PRODUCTION / labor     labor
27                                  capital    capital
28                                  land       agricultural land /
29
30   INS     INSTITUTIONS         / labr       labor
31                                  ent        enterprises
32                                  prop       property /
33
34   HH      HOUSEHOLD TYPE       / hhtrn      transfer recipients
35                                  hhlab      wage earners
36                                  hhcap      rentiers /
37
38   * The institution names and the factor names "capital" and "land"
39   * are referred to explicitly below.  If changed, they must also be
40   * changed where referenced.
41   * The printing of the GNP accounts assume that there is a sector
42   * labelled "service."
43
44   *## SUBSETS DEFINED BELOW: "DEFINE INDEXES"
45
46   IAG(I)          AG SECTORS        / lvstk, expcrp, othcrp /
47   IAGN(I)         NON AG SECTORS
48
49   IE(I)           EXPORT SECTORS
50   IED(I)          SECTORS WITH EXPORT DEMAND EQN
51   IEDN(I)         SECTORS WITH NO EXPORT DEMAND EQN
52   IEN(I)          NON EXPORT SECTORS
53
54   IM(I)           IMPORT SECTORS
55   IMN(I)          NON IMPORT SECTORS
56
57   ALIAS(I,J) ;
58
59  *## for SAM
60   SET ISAM   categories
61                      /COMMDTY,ACTIVITY,VALUAD,INSTTNS,HOUSEHOLDS,
62                       GOVT,KACCOUNT,WORLD,TOTAL/
63       ISAM1(isam)     /TOTAL/
64       ISAM2(isam) ;
65   ALIAS(isam2,isam3);
66   PARAMETER SAM(isam,isam) SOCIAL ACCOUNTING MATRIX ;
67   isam2(isam) = NOT isam1(isam) ;
68
```

```
69
70   *######################### PARAMETER DECLARATION #####################
71
72     PARAMETERS
73
74   *### READ IN PARAMETERS
75
76   *## READ IN FOR INITIALIZATION OF VARIABLES
77     ENTTAX0      ENTERPRISE TAX REVENUE
78     ENTSAV0      ENTERPRISE SAVINGS
79     EXR0         EXCHANGE RATE
80     E0(i)        EXPORTS
81     FBOR0        NET FOREIGN BORROWING
82     FSAV0        NET FOREIGN SAVINGS
83     GDTOT0       TOTAL VOLUME OF GOVERNMENT CONSUMPTION
84     GENT0        PAYMENTS FROM GOVERNMENT TO ENTERPRISES
85     GOVSAV0      GOVERNMENT SAVINGS
86     HHSAV0       HOUSEHOLD SAVINGS
87     HHT0         HOUSEHOLD TRANSFERS
88     INVEST0      TOTAL INVESTMENT
89     M0(i)        IMPORTS
90     MPS0(hh)     HOUSEHOLD MARGINAL PROPENSITY TO SAVE
91     PD0(i)       DOMESTIC GOODS PRICE
92     PE0(i)       DOMESTIC PRICE OF EXPORTS
93     PINDEX0      GNP DEFLATOR
94     PM0(i)       DOMESTIC PRICE OF IMPORTS
95     REMIT0       NET REMITTANCES FROM ABROAD
96     SSTAX0       SOCIAL SECURITY TAX REVENUE
97     TOTHHTAX0    HOUSEHOLD TAX REVENUE
98     XD0(i)       DOMESTIC OUTPUT, VOLUMNE
99
100  *# READ IN TABLE FOR INITIALIZATION OF VARIABLES (NEED NOT BE DECLARED)
101  * TABLE FCTRES1(i,f) FACTOR DEMAND BY SECTOR
102  * TABLE FCTRY(i,f)   FACTOR INCOME BY SECTOR
103
104  *## READ IN PARAMETERS AS RATES, SHARES, ELASTICITIES
105    DEPR(i)      DEPRECIATION RATES
106    DSTR(i)      RATIO OF INVENTORY INVESTMENT TO GROSS OUTPUT
107    ESR          ENTERPRISE SAVINGS RATE
108    ETR          ENTERPRISE TAX RATE
109    GLES(i)      GOVERNMENT CONSUMPTION SHARES
110    HTAX(hh)     HOUSEHOLD TAX RATE
111    ITAX(i)      INDIRECT TAX RATES
112    KISH(i)      SHARES OF INVESTMENT BY SECTOR OF DESTINATION
113    RHSH(hh)     HOUSEHOLD REMITTANCE SHARE
114    RHOC(i)      ARMINGTON FUNCTION EXPONENT
115    RHOE(i)      EXPORT DEMAND PRICE ELASTICITY
116    RHOT(i)      CET FUNCTION EXPONENT
117    SSTR         SOCIAL SECURITY TAX RATE
118    TE(i)        EXPORT SUBSIDY RATES
119    TM(i)        TARIFF RATES ON IMPORTS
120    THSH(hh)     HOUSEHOLD SHARES OF GOVERNMENT TRANSFERS
121
122  *# READ IN TABLE OF PARAMETERS (NEED NOT BE DECLARED)
123  * TABLE CLES(i,hh)      HOUSEHOLD CONSUMPTION SHARES
124  * TABLE IMAT(i,j)       CAPITAL COMPOSITION MATRIX
125  * TABLE IO(i,j)         INPUT-OUTPUT COEFFICIENTS
126  * TABLE SINTYH(hh,ins)  HOUSEHOLD DISTRIBUTION OF INSTITUTIONAL INCOME
127
128  *### COMPUTED PARAMETERS FROM READ IN DATA (CALIBRATION)
129
130  *## COMPUTED PARAMETERS FOR INITIALIZATION OF VARIABLES
131    DEPRECIA0    TOTAL DEPRECIATION EXPENDITURE
132    FD0(f)       FACTOR DEMAND, AGGREGATE
133    FS0(f)       FACTOR SUPPLY, AGGREGATE
134    INT0(i)      INTERMEDIATE INPUT DEMAND
135    NETSUB0      EXPORT DUTY REVENUE
136    P0(i)        PRICE OF COMPOSITE GOOD
137    PK0(i)       CAPITAL GOODS PRICE BY SECTOR OF DESTINATION
```

```
138    PVAO(i)       VALUE ADDED PRICE BY SECTOR
139    PWM(i)        WORLD MARKET PRICE OF IMPORTS (IN DOLLARS)
140    PWEO(i)       WORLD PRICE OF EXPORTS
141    PWSE(i)       WORLD PRICE OF EXPORT SUBSTITUTES
142    PXO(i)        AVERAGE OUTPUT PRICE
143    VARO(i)       VALUE ADDED RATE BY SECTOR
144    WFDIST(i,f)   FACTOR PRICE SECTORAL PROPORTIONALITY CONSTANTS
145    WFO(f)        FACTOR PRICE, AGGREGATE AVERAGE
146    XXDO(i)       DOMESTIC SALES, VOLUMNE
147    XO(i)         COMPOSITE GOOD SUPPLY, VOLUMNE
148    YFCTRO(f)     FACTOR INCOME SUMMED OVER SECTOR
149    YFLANDO(i)    FACTOR INCOME FOR LAND AS FRACTION OF CAPITAL INCOME
150    YFSECTO(i)    FACTOR INCOME BY SECTOR
151    YHO(hh)       HOUSEHOLD INCOME
152    YINSTO(ins)   INSTITUTIONAL INCOME
153
154    *## COMPUTED PARAMETERS AS RATES, SHARES
155    AC(i)         ARMINGTON FUNCTION SHIFT PARAMETER
156    AD(i)         PRODUCTION FUNCTION SHIFT PARAMETER
157    ALPHA(i,f)    FACTOR SHARE PARAMETER-PRODUCTION FUNCTION
158    AT(i)         CET FUNCTION SHIFT PARAMETER
159    DELTA(i)      ARMINGTON FUNCTION SHARE PARAMETER
160    ECONST(i)     EXPORT DEMAND CONSTANT
161    GAMMA(i)      CET FUNCTION SHARE PARAMETER
162    PWTS(i)       PRICE INDEX WEIGHTS
163    QD(i)         DUMMY VARIABLE FOR COMPUTING AD(i)
164    RMD(i)        RATIO OF IMPORTS TO DOMESTIC SALES
165    SUMSH         SUM OF SHARE CORRECTION PARAMETER
166    SUMHHSH(hh)   SUM OF SHARE FOR HH CLES
167    SUMIMSH(i)    SUM OF SHARE FOR IMAT
168    TEREAL(i)     REAL EXPORT SUBSIDY RATE IN 1982 DOLLARS
169    TMREAL(i)     REAL TARIFF RATE IN 1982 DOLLARS
170          ;
171
172    *## TABLES USED FOR LOADING VARIABLE RESULTS
173    * TABLE SCALRES(*)      AGGREGATE RESULTS
174    * TABLE SECTRES(*,i)    SECTORAL PRICE AND QUANTITY RESULTS
175    * TABLE FCTRES1(i,f)    FACTOR DEMAND RESULTS
176    * TABLE FCTRES2(*,f)    FACTOR WAGE, SUPPLY AND INCOME RESULTS
177    * TABLE INSRES(*,ins)   INSTITUTIONAL INCOME RESULTS
178    * TABLE HHRES(*,hh)     HOUSEHOLD SAVINGS AND INCOME RESULTS
179
180
181    *######################## PARAMETER ASSIGNMENT #####################
182
183
184    TABLE IO(i,j) INPUT-OUTPUT COEFFICIENTS
185
186                    LVSTK       EXPCRP      OTHCRP      AGPROC      AGINP
187
188    LVSTK        0.168150    0.028372    0.008224    0.136023    0.000958
189    EXPCRP       0.271862    0.063924    0.003564    0.042413    0.010264
190    OTHCRP       0.001403    0.001924    0.034676    0.029118    0.000696
191    AGPROC       0.027162    0.001427    0.003346    0.219018    0.016157
192    AGINP        0.215859    0.194453    0.141894    0.008308    0.127179
193    INTMNF       0.007833    0.023602    0.042830    0.096847    0.488054
194    FDMNF        0.013962    0.014380    0.015201    0.037832    0.026911
195    TRDTRN       0.064683    0.066275    0.057563    0.078776    0.086941
196    SERVICE      0.061396    0.076441    0.063132    0.068066    0.086447
197    RESTA        0.022761    0.101945    0.042404    0.003908    0.004418
198
199       +          INTMNF      FDMNF       TRDTRN      SERVICE     RESTA
200
201    LVSTK        0.000265    0.000059    0.000069    0.000575    0.000000
202    EXPCRP       0.000124    0.000037    0.000086    0.000355    0.000005
203    OTHCRP       0.001697    0.000165    0.000072    0.000630    0.000078
204    AGPROC       0.005055    0.011437    0.001673    0.020583    0.000037
205    AGINP        0.032723    0.012603    0.045185    0.020652    0.005944
206    INTMNF       0.283883    0.167023    0.011284    0.069580    0.001440
```

46

207	FDMNF	0.048351	0.233953	0.031024	0.043826	0.008954
208	TRDTRN	0.069999	0.070436	0.074135	0.040961	0.004047
209	SERVICE	0.106268	0.100089	0.156346	0.156056	0.091112
210	RESTA	0.023195	0.009930	0.026575	0.022218	0.070271
211	;					
212						

213 TABLE IMAT(i,j) CAPITAL COMPOSITION MATRIX

214

215		LVSTK	EXPCRP	OTHCRP	AGPROC	AGINP
216						
217	LVSTK	0.000000	0.000000	0.000000	0.000000	0.000000
218	EXPCRP	0.000000	0.000000	0.000000	0.000000	0.000000
219	OTHCRP	0.000000	0.000000	0.000000	0.000000	0.000000
220	AGPROC	0.000024	0.000000	0.000000	0.000128	0.000048
221	AGINP	0.107920	0.572183	0.572183	0.000449	0.045514
222	INTMNF	0.021095	0.012547	0.012547	0.038457	0.054939
223	FDMNF	0.358399	0.109671	0.109671	0.852829	0.746376
224	TRDTRN	0.000000	0.000000	0.000000	0.000000	0.000000
225	SERVICE	0.512562	0.305599	0.305599	0.108137	0.153123
226	RESTA	0.000000	0.000000	0.000000	0.000000	0.000000
227						

228	+	INTMNF	FDMNF	TRDTRN	SERVICE	RESTA
229						
230	LVSTK	0.000000	0.000000	0.000000	0.000000	0.000000
231	EXPCRP	0.000000	0.000000	0.000000	0.000000	0.000000
232	OTHCRP	0.000000	0.000000	0.000000	0.000000	0.000000
233	AGPROC	0.000039	0.000088	0.000326	0.003320	0.003957
234	AGINP	0.001101	0.000340	0.000371	0.008710	0.011875
235	INTMNF	0.043006	0.011048	0.007640	0.018766	0.000125
236	FDMNF	0.626612	0.886306	0.867568	0.235520	0.055912
237	TRDTRN	0.000000	0.000000	0.000000	0.000000	0.000000
238	SERVICE	0.329243	0.102218	0.124095	0.708126	0.891418
239	RESTA	0.000000	0.000000	0.000000	0.025558	0.036713
240	;					

241

242

243 * FACTORS OF PRODUCTION

244

245 * LABOR IN MILLIONS OF EMPLOYEES
246 * CAPITAL IN BILLIONS OF 1982 $
247 * LAND IN MILLIONS OF ACRES
248 TABLE FCTRES1(i,f) FACTOR DEMAND BY SECTOR

249

250		LABOR	CAPITAL	LAND
251				
252	LVSTK	0.415354	79.844060	0.000000
253	EXPCRP	0.389786	72.290527	342.600000
254	OTHCRP	0.495860	27.070413	85.650000
255	AGPROC	3.584813	90.828916	0.000000
256	AGINP	0.887448	80.391908	0.000000
257	INTMNF	5.635211	574.659325	0.000000
258	FDMNF	9.907532	291.267850	0.000000
259	TRDTRN	18.648095	516.104860	0.000000
260	SERVICE	55.605901	3871.778753	0.000000
261	RESTA	1.070999	639.835386	0.000000
262	;			

263

264 * NOTE, CROPLAND INCOME IS READ AS A FRACTION OF CAPITAL INCOME
265 TABLE FCTRY(i,f) FACTOR INCOME BY SECTOR

266

267		LABOR	CAPITAL	LAND
268				
269	LVSTK	4.792637	5.014664	0.000000
270	EXPCRP	3.323859	26.065318	0.630000
271	OTHCRP	4.906739	10.292489	0.630000
272	AGPROC	65.741305	32.884451	0.000000
273	AGINP	20.248245	13.974888	0.000000
274	INTMNF	153.872100	115.536383	0.000000
275	FDMNF	263.093487	49.561461	0.000000

```
276    TRDTRN      330.332692  107.022255    0.000000
277    SERVICE    1048.780635  493.262171    0.000000
278    RESTA         11.908460  146.610508    0.000000
279       ;
280
281  *## HOUSEHOLD PARAMETERS
282
283   TABLE CLES(i,hh) HOUSEHOLD CONSUMPTION SHARES
284
285                   HHTRN        HHLAB        HHCAP
286
287    LVSTK         0.003931     0.003217     0.002309
288    EXPCRP        0.000326     0.000470     0.000494
289    OTHCRP        0.006344     0.005539     0.004931
290    AGPROC        0.119976     0.114408     0.097157
291    AGINP         0.024630     0.028957     0.022995
292    INTMNF        0.010660     0.011127     0.010686
293    FDMNF         0.089590     0.108451     0.113151
294    TRDTRN        0.190825     0.188008     0.188198
295    SERVICE       0.516858     0.502351     0.518905
296    RESTA         0.036861     0.037470     0.041175
297       ;
298
299  * NOTE, MPS(HHCAP) AND HTAX(HHLAB) ARE RECOMPUTED BELOW FROM VALUE DATA
300   TABLE HHPAR(*,hh) MISCELLANEOUS HOUSEHOLD PARAMETERS
301
302                   HHTRN        HHLAB        HHCAP
303
304    THSH          1.000000     0.000000     0.000000
305    RHSH          0.000000     0.000000     1.000000
306    HTAX          0.000000     0.125960     0.350000
307    MPS           0.000000     0.061607     0.174295
308       ;
309
310
311  *## INSTITUTIONAL PARAMETERS
312
313   TABLE SINTYH(HH,INS) HOUSEHOLD DISTRIBUTION OF INCOME
314
315                   LABR         ENT          PROP
316
317    HHTRN         0.000000     0.000000     0.000000
318    HHLAB         1.000000     0.000000     0.000000
319    HHCAP         0.000000     1.000000     1.000000
320       ;
321
322
323  *## PRODUCTION SECTOR PARAMETERS
324
325   TABLE SECTRES(*,I)  SECTORAL QUANTITIES AND PRICES
326
327                   LVSTK       EXPCRP       OTHCRP       AGPROC       AGINP
328
329    XD           77.115329    71.772915    26.543600   391.145476   265.279751
330    E             0.211590    17.906935     1.517508    18.226606    19.340732
331    M             0.653649     0.116664     2.782416    26.562680    23.669242
332    PX            1.000000     1.000000     1.000000     1.000000     1.000000
333    PE            1.000000     1.000000     1.000000     1.000000     1.000000
334    PM            1.000000     1.000000     1.000000     1.000000     1.000000
335    P             1.000000     1.000000     1.000000     1.000000     1.000000
336    PD            1.000000     1.000000     1.000000     1.000000     1.000000
337    PK            1.000000     1.000000     1.000000     1.000000     1.000000
338
339        +         INTMNF       FDMNF        TRDTRN       SERVICE      RESTA
340
341    XD          691.752575   817.593692   785.067268  2609.047268   230.939170
342    E            46.868929   108.003057    37.123239   107.252244     5.449350
343    M            89.196218   151.445719     1.845284    47.928267     0.000000
344    PX            1.000000     1.000000     1.000000     1.000000     1.000000
```

345	PE	1.000000	1.000000	1.000000	1.000000	1.000000
346	PM	1.000000	1.000000	1.000000	1.000000	1.000000
347	P	1.000000	1.000000	1.000000	1.000000	1.000000
348	PD	1.000000	1.000000	1.000000	1.000000	1.000000
349	PK	1.000000	1.000000	1.000000	1.000000	1.000000

```
350       ;
351
352  * NOTE, TAXES ARE MAGNITUDES AND RATES ARE COMPUTED
353  TABLE TAXR(*,I)   SECTORAL TAXES
354
```

355		LVSTK	EXPCRP	OTHCRP	AGPROC	AGINP
356						
357	ITAX	1.368870	1.276232	0.386298	10.774114	6.092757
358	TE	0.000000	0.000000	0.000000	0.000000	0.000000
359	TM	0.008711	0.003304	0.099223	2.746818	0.062378
360						
361	+	INTMNF	FDMNF	TRDTRN	SERVICE	RESTA
362						
363	ITAX	26.965991	9.696082	75.726551	87.474192	30.415138
364	TE	0.000000	0.000000	0.000000	0.000000	0.000000
365	TM	1.601493	4.028613	0.049061	0.000400	0.000000

```
366       ;
367
368  TABLE PARM(*,I)   MISCELLANEOUS PARAMETERS
369
```

370		LVSTK	EXPCRP	OTHCRP	AGPROC	AGINP
371						
372	DEPR	0.108183	0.108183	0.108183	0.095055	0.084635
373	DSTR	0.000811	-0.006647	-0.004847	-0.006132	-0.008088
374	GLES	0.000671	0.011649	0.001061	0.014240	0.019479
375	KISH	0.012787	0.011577	0.004335	0.014547	0.012875
376						
377	+	INTMNF	FDMNF	TRDTRN	SERVICE	RESTA
378						
379	DEPR	0.111027	0.094561	0.093504	0.046913	0.042354
380	DSTR	-0.006272	-0.010781	-0.003641	-0.001304	0.000000
381	GLES	0.019867	0.152708	0.044819	0.725589	0.009918
382	KISH	0.092033	0.046648	0.082656	0.620072	0.102470

```
383       ;
384
385
386  PARAMETER SCALRES(*) /
387  *#### MACRO TOTALS
388  EXR       =     1.000000
389  PINDEX    =     1.000000
390  GDTOT     =   641.700000
391  INVEST    =   447.300122
392  *#### TAX
393  SSTAX     =   269.535402
394  ENTTAX    =    63.079602
395  TOTHHTAX  =   409.335747
396  *#### TRANSFER
397  REMIT     =    -1.250000
398  GENT      =    47.530000
399  HHT       =   396.249995
400  FBOR      =   -26.080000
401  *#### SAVE
402  ENTSAV    =    20.030311
403  HHSAV     =   153.907922
404  GOVSAV    =  -110.833017
405  FSAV      =     1.029951
406       /  ;
407
408  TABLE ELASTICITY(*,I)   SECTORAL ELASTICITIES
409
```

410		LVSTK	EXPCRP	OTHCRP	AGPROC	AGINP
411						
412	RHOC	4.0	4.0	4.0	2.0	0.75
413	RHOT	0.5	4.0	2.0	2.0	2.0

49

```
414    RHOE    3.0         3.0         3.0
415
416     +      INTMNF      FDMNF      TRDTRN     SERVICE    RESTA
417
418    RHOC    0.75        0.9        1.1        0.2        0.5
419    RHOT    2.0         1.5        2.0        0.6        0.6
420    RHOE
421            ;
422
423    *################## END PARAMETER ASSIGNMENT #######################
424
425    *############ SPECIFY PARAMETERS FROM TABLE VALUES #################
426
427    *## PARAMETERS FROM SCALRES(*)
428    ENTSAV0     = SCALRES("ENTSAV");
429    ENTTAX0     = SCALRES("ENTTAX");
430    EXR0        = SCALRES("EXR") ;
431    FBOR0       = SCALRES("FBOR") ;
432    FSAV0       = SCALRES("FSAV") ;
433    GDTOT0      = SCALRES("GDTOT") ;
434    GENT0       = SCALRES("GENT");
435    GOVSAV0     = SCALRES("GOVSAV") ;
436    HHSAV0      = SCALRES("HHSAV") ;
437    HHT0        = SCALRES("HHT") ;
438    INVEST0     = SCALRES("INVEST") ;
439    PINDEX0     = SCALRES("PINDEX") ;
440    REMIT0      = SCALRES("REMIT") ;
441    SSTAX0      = SCALRES("SSTAX");
442    TOTHHTAX0   = SCALRES("TOTHHTAX") ;
443
444    *## OTHER TABLE VALUES OF PARAMETERS
445    E0(i)       = SECTRES("E",i) ;
446    ECONST(i)   = SECTRES("E",i) ;
447    M0(i)       = SECTRES("M",i) ;
448    PX0(i)      = SECTRES("PX",i) ;
449    PE0(i)      = SECTRES("PE",i) ;
450    PM0(i)      = SECTRES("PM",i) ;
451    P0(i)       = SECTRES("P",i) ;
452    PD0(i)      = SECTRES("PD",i) ;
453    PK0(i)      = SECTRES("PK",i) ;
454    XD0(i)      = SECTRES("XD",i);
455
456    HTAX(hh)    = HHPAR("HTAX",hh) ;
457    MPS0(hh)    = HHPAR("MPS",hh) ;
458    RHSH(hh)    = HHPAR("RHSH",hh);
459    THSH(hh)    = HHPAR("THSH",hh);
460
461    ITAX(i)     = TAXR("ITAX",i)/(PX0(i)*XD0(i)) ;
462
463    RHOC(i)     = (1/ELASTICITY("rhoc",i)) - 1 ;
464    RHOE(i)     = ELASTICITY("rhoe",i);
465    RHOT(i)     = (1/ELASTICITY("RHOT",i)) + 1;
466
467    DEPR(i)     = PARM("DEPR",i) ;
468    DSTR(i)     = PARM("DSTR",i) ;
469    GLES(i)     = PARM("GLES",i);
470    KISH(i)     = PARM("KISH",i) ;
471
472    *## NORMALIZE SHARE PARAMETERS TO CORRECT FOR ROUNDOFF ERROR
473    * These parameters (cles, imat, kish, and gles) can be read in as values
474    * and coverted to shares here.
475    SUMHHSH(hh) = SUM(i, CLES(i,hh)) ;
476    CLES(i,hh)  = CLES(i,hh)/SUMHHSH(hh) ;
477    SUMIMSH(j)  = SUM(i, IMAT(i,j)) ;
478    IMAT(i,j)   = IMAT(i,j)/SUMIMSH(j) ;
479    SUMSH       = SUM(i, KISH(i)) ;
480    KISH(i)     = KISH(i)/SUMSH ;
481    SUMSH       = SUM(i, GLES(i)) ;
482    GLES(i)     = GLES(i)/SUMSH ;
```

```
483
484  *#### DEFINE INDEXES BASED ON READ IN DATA
485  IAGN(i)       = not IAG(i);
486  IE(i)         = yes$E0(i);
487  IED(i)        = yes$RHOE(i);
488  IEDN(i)       = not IED(i);
489  IEN(i)        = not IE(i);
490  IM(i)         = yes$M0(i);
491  IMN(i)        = not IM(i);
492
493  *## SPECIFY PARAMETERS WHICH DEPEND ON DEFINED INDEX IM AND IE
494  TM(imn)       = 0.0 ;
495  TM(im)        = TAXR("TM",im)/(PMO(im)*MO(im) - TAXR("TM",im)) ;
496  TE(ien)       = 0.0 ;
497  TE(ie)        = TAXR("TE",ie)/(PEO(ie)*EO(ie) - TAXR("TE",ie)) ;
498
499  *## COMPUTE FROM INITIAL DATA
500  INTO(i)       = SUM(j, IO(i,j)*XDO(j));
501  PVAO(i)       = PXO(i) - SUM(j, IO(j,i)*PO(j)) - ITAX(i) ;
502  PWEO(i)       = PEO(i)/((1+TE(i))*EXRO);
503  PWM(i)        = PMO(i)/((1+TM(i))*EXRO);
504  VARO(i)       = PVAO(i) + ITAX(i) ;
505  XXDO(i)       = XDO(i) - EO(i) ;
506
507  *## FOR 1982 TMREAL AND TEREAL ARE DERIVE FROM TM AND TE
508  *## FOR OTHER YEARS READ IN TMREAL AND TEREAL
509  TMREAL(i)     = TM(i)*PWM(i)*EXRO ;
510  TEREAL(i)     = TE(i)*PWEO(i)*EXRO ;
511  NETSUBO       = SUM(i, TE(i)*EO(i)*PWEO(i))*EXRO ;
512
513
514  *############### CALIBRATION OF PARAMETERS FROM DATA ############
515
516  *## ADJUST FACTOR INCOME (CAPITAL) FOR FARM LAND
517  YFLANDO(i)           = FCTRY(i,"land") ;
518  FCTRY(i,"land")      = FCTRY(i,"capital")*YFLANDO(i) ;
519  FCTRY(i,"capital") = FCTRY(i,"capital")*(1.0 - YFLANDO(i)) ;
520
521  *## FACTOR MARKET PARAMETERS
522  FSO(f)        = SUM(i,FCTRES1(i,f)) ;
523  YFCTRO(f)     = SUM(i, FCTRY(i,f)) ;
524  YFSECTO(i)    = SUM(f, FCTRY(i,f)) ;
525  WFO(f)        = YFCTRO(f)/FSO(f) ;
526  WFDIST(i,f)$FCTRES1(i,f) = (FCTRY(i,f)/FCTRES1(i,f))/WFO(f) ;
527  WFDIST(i,f)$(FCTRES1(i,f) EQ 0) = 0.0 ;
528
529  *## INSTITUTIONAL AND HOUSEHOLD INCOME, TAX RATE, AND SAVING RATE
530  DEPRECIAO = SUM(i, DEPR(i)*PKO(i)*FCTRES1(i,"capital") ) ;
531  SSTR = SSTAXO/YFCTRO("labor") ;
532  ETR = ENTTAXO/(YFCTRO("capital") + GENTO - DEPRECIAO) ;
533  ESR = ENTSAVO/(YFCTRO("capital") - ENTTAXO + GENTO - DEPRECIAO) ;
534  YINSTO("labr") = (1.0 - SSTR)*YFCTRO("labor") ;
535  YINSTO("ent")  = YFCTRO("capital") - ENTSAVO - ENTTAXO + GENTO
536                    - DEPRECIAO ;
537  YINSTO("prop") = YFCTRO("land") ;
538
539  *## NOTE, HOUSEHOLD INCOME IS FROM FACTORS (YHVAO) AND TRANSFERS
540  *## WHERE, YHVAO(hh) = SUM(ins, SINTYH(hh,ins)*YINSTO(ins))
541  YHO(hh) = SUM(ins, SINTYH(hh,ins)*YINSTO(ins))
542              + REMITO*RHSH(hh)*EXRO + HHTO*THSH(hh) ;
543
544  *## COMPUTE HTAX(hhlab) GIVEN OTHER HH TAX RATES AND TOTHHTAXO
545  *## WHERE, TOTHHTAXO = SUM(hh, HTAX(hh)*YHO(hh))
546  HTAX("hhlab") = (TOTHHTAXO - HTAX("hhtrn")*YHO("hhtrn")
547                    - HTAX("hhcap")*YHO("hhcap"))/YHO("hhlab");
548
549  *## COMPUTE MPSO(hhcap) GIVEN OTHER HH SAVINGS RATES AND HHSAVO
550  *## WHERE, HHSAVO = SUM(hh, MPSO(hh)*YHO(hh)*(1.0 - HTAX(hh)))
551  MPSO("hhcap")=(HHSAVO - MPSO("hhtrn")*YHO("hhtrn")*(1.0-HTAX("hhtrn"))
```

```
552                            - MPSO("hhlab")*YHO("hhlab")*(1.0-HTAX("hhlab")))
553                  /(YHO("hhcap")*(1.0 - HTAX("hhcap"))) ;
554
555
556   DISPLAY WFDIST, WFO, FSO, YFSECTO, YFCTRO ;
557   DISPLAY YINSTO,YHO,MPSO,HTAX,ETR,ESR,SSTR ;
558
559  *#### CALIBRATION OF SHIFT AND SHARE PARAMETERS ####
560
561  *## FOR IMPORTS-DOMESTIC COMPOSITE
562  *##  get delta from costmin, xo from absorption, ac from armington
563
564   DELTA(i)      = (PMO(i)/PDO(i))*(MO(i)/XXDO(i))**(1+RHOC(i)) ;
565   DELTA(i)      = DELTA(i)/(1.0+DELTA(i)) ;
566   XO(i)         = (PDO(i)*XXDO(i) + (PMO(i)*MO(i))$im(i))/PO(i) ;
567   RMD(i)        = MO(i)/XXDO(i) ;
568   AC(i)$im(i)   = XO(i)/(DELTA(i)*MO(i)**(-RHOC(i))
569                       +(1-DELTA(i))*XXDO(i)**(-RHOC(i)))**(-1/RHOC(i)) ;
570   AC(i)$imn(i) = 1.0 ;
571   display DELTA,AC,RMD ;
572
573  *## FOR EXPORTS
574  *## GET GAMMA FROM ESUPPLY
575   GAMMA(ie)     = 1/(1 + PDO(ie)/PEO(ie)*(EO(ie)/XXDO(ie))**(RHOT(ie)-1));
576  *## GET AT FROM CET
577   AT(ie)        = XDO(ie)/(GAMMA(ie)*EO(ie)**RHOT(ie) + (1-GAMMA(ie))*
578                   XXDO(ie)**RHOT(ie))**(1/RHOT(ie)) ;
579   display GAMMA,AT ;
580
581  *## FOR FACTOR DEMAND
582  *## GET ALPHA FROM PROFIT MAX (ALPHA FOR EACH i SHOULD SUM TO 1)
583   ALPHA(i,f)    = (WFDIST(i,f)*WFO(f)*FCTRES1(i,f))/YFSECTO(i) ;
584   DISPLAY ALPHA ;
585
586  *## get AD from output and FDO from profitmax
587   QD(i)         = PROD(f, FCTRES1(i,f)**ALPHA(i,f)) ;
588   AD(i)         = XDO(i)/QD(i);
589   FDO(f)        = SUM(i,(XDO(i)*PVAO(i)*ALPHA(i,f)/(WFDIST(i,f)*
590                   WFO(f)))$WFDIST(i,f)) ;
591   DISPLAY AD,QD,FDO ;
592
593  *## SPECIFY WEIGHTS FOR PRODUCER PRICE INDEX
594   PWTS(i)       = XDO(i)/SUM(j, XDO(j)) ;
595
596  *#### END OF CALIBRATION ####
597   DISPLAY XDO, XO, XXDO ;
598   DISPLAY PVAO,PDO, PEO, PWEO, PMO, PWM, TM, PWTS ;
599
600  *##################################################################
601
602   VARIABLES
603
604  *#################### VARIABLE DECLARATION ########################
605
606  *## PRICE BLOCK
607     EXR         EXCHANGE RATE                          ($ PER WORLD $)
608     P(i)        PRICE OF COMPOSITE GOODS
609     PD(i)       DOMESTIC PRICES
610     PE(i)       DOMESTIC PRICE OF EXPORTS
611     PINDEX      GNP DEFLATOR
612     PK(i)       PRICE OF CAPITAL GOODS BY SECTOR OF DESTINATION
613     PM(i)       DOMESTIC PRICE OF IMPORTS
614     PVA(i)      VALUE ADDED PRICE
615     PWE(i)      WORLD PRICE OF EXPORTS
616     PX(i)       AVERAGE OUTPUT PRICE
617  *## PRODUCTION BLOCK
618     E(i)        EXPORTS                                (82 BILL $)
619     M(i)        IMPORTS                                (82 BILL $)
620     X(i)        COMPOSITE GOODS SUPPLY                 (82 BILL $)
```

```
621     XD(i)      DOMESTIC OUTPUT                                     (82 BILL $)
622     XXD(i)     DOMESTIC SALES                                      (82 BILL $)
623   *## FACTOR BLOCK
624     FS(f)      FACTOR SUPPLY
625     FDSC(i,f)  FACTOR DEMAND BY SECTOR
626     WF(f)      AVERAGE FACTOR PRICE
627     YFCTR(f)   FACTOR INCOME                                       (BILL $)
628   *## INCOME AND EXPENDITURE BLOCK
629     CD(i)      FINAL DEMAND FOR PRIVATE CONSUMPTION                (82 BILL $)
630     DEPRECIA   TOTAL DEPRECIATION EXPENDITURE                      (BILL $)
631     DK(i)      VOLUME OF INVESTMENT BY SECTOR OF DESTINATION (82 BILL $)
632     DST(i)     INVENTORY INVESTMENT BY SECTOR                      (82 BILL $)
633     ENTSAV     ENTERPRISE SAVINGS                                  (BILL $)
634     ENTTAX     ENTERPRISE TAX REVENUE                              (BILL $)
635     FBOR       NET FOREIGN BORROWING                               (BILL WORLD $)
636     FSAV       NET FOREIGN SAVINGS                                 (BILL WORLD $)
637     FXDINV     FIXED CAPITAL INVESTMENT                            (BILL $)
638     GD(i)      FINAL DEMAND FOR GOVERNMENT CONSUMPTION             (82 BILL $)
639     GDTOT      TOTAL VOLUME OF GOVERNMENT CONSUMPTION              (82 BILL $)
640     GENT       PAYMENTS FROM GOVT TO ENT                           (BILL $)
641     GOVSAV     GOVERNMENT SAVINGS                                  (BILL $)
642     GR         GOVERNMENT REVENUE                                  (BILL $)
643     HHSAV      TOTAL HOUSEHOLD SAVINGS                             (BILL $)
644     HHT        HOUSEHOLD TRANSFERS                                 (BILL $)
645     ID(i)      FINAL DEMAND FOR PRODUCTIVE INVESTMENT              (82 BILL $)
646     INDTAX     INDIRECT TAX REVENUE                                (BILL $)
647     INT(i)     INTERMEDIATES USES                                  (82 BILL $)
648     INVEST     TOTAL INVESTMENT                                    (BILL $)
649     MPS(hh)    MARGINAL PROPENSITY TO SAVE BY HOUSEHOLD TYPE
650     NETSUB     EXPORT DUTY REVENUE                                 (BILL $)
651     REMIT      NET REMITTANCES FROM ABROAD                         (BILL WORLD $)
652     SAVINGS    TOTAL SAVINGS                                       (BILL $)
653     SSTAX      SOCIAL SECURITY TAX REVENUE                         (BILL $)
654     TARIFF     TARIFF REVENUE                                      (BILL $)
655     TOTHHTAX   HOUSEHOLD TAX REVENUE                               (BILL $)
656     YH(hh)     HOUSEHOLD INCOME                                    (BILL $)
657     YINST(ins) INSTITUTIONAL INCOME                                (BILL $)
658   *## GNP CALCULATIONS
659     RGNP       REAL GNP                                            (82 BILL $)
660     GNPVA      VALUE ADDED IN MARKET PRICES GNP                    (BILL $)
661          ;
662
663
664   *################# VARIABLE INITIALIZATION #####################
665
666   *## USE INITIAL VALUES OF VARIABLES (FROM PARAMETER SPECIFICATION)
667     EXR.L      = EXRO ;
668     FBOR.L     = FBORO ;
669     FSAV.L     = FSAVO ;
670     GDTOT.L    = GDTOTO ;
671     GENT.L     = GENTO ;
672     GOVSAV.L   = GOVSAVO ;
673     HHT.L      = HHTO ;
674     INVEST.L   = INVESTO ;
675     PINDEX.L   = PINDEXO ;
676     REMIT.L    = REMITO ;
677
678     MPS.L(hh)  = MPSO(hh) ;
679
680     PD.L(i)    = PDO(i) ;
681     P.L(i)     = PO(i) ;
682     PX.L(i)    = PXO(i) ;
683     PM.L(i)    = PMO(i) ;
684     PE.L(i)    = PEO(i) ;
685     XD.L(i)    = XDO(i) ;
686     E.L(i)     = EO(i) ;
687     M.L(i)     = MO(i) ;
688
689     FDSC.L(i,f) = FCTRES1(i,f) ;
```

```
690    YFCTR.L(f)    = SUM(i, FCTRY(i,f)) ;
691
692    *## COMPUTE INITIAL VALUES FOR OTHER VARIABLES
693    *## OUTPUT AND PRICE
694    XXD.L(i) = XD.L(i) - E.L(i) ;
695    X.L(i)    = (PD.L(i)*XXD.L(i) + (PM.L(i)*M.L(i))$IM(i))/P.L(i) ;
696    PK.L(i)   = SUM(J, P.L(j)*IMAT(j,i)) ;
697    PWE(i) = PE.L(i)/((1.0 + TE(i))*EXR.L) ;
698    PWSE(i)   = PWE.L(i) ;
699    PVA.L(i)  = PX.L(i) - SUM(J, IO(j,i)*P.L(j)) - ITAX(i) ;
700
701    *## VALUE ADDED AND THE FLOW OF FACTOR INCOME
702    FS.L(f)             = SUM(i, FDSC.L(i,f)) ;
703    WF.L(f)             = YFCTR.L(f)/FS.L(f) ;
704    NETSUB.L            = SUM(ie, TE(ie)*E.L(ie)*PWE.L(ie))*EXR.L ;
705    TARIFF.L            = SUM(im, PWM(im)*M.L(im)*TM(im))*EXR.L ;
706    SSTAX.L             = SSTR*YFCTR.L("labor") ;
707    INDTAX.L            = SUM(i, ITAX(i)*PX.L(i)*XD.L(i)) ;
708    DEPRECIA.L          = SUM(i, DEPR(i)*PK.L(i)*FDSC.L(i,"capital")) ;
709    ENTTAX.L            = ETR*(YFCTR.L("capital") + GENT.L - DEPRECIA.L) ;
710    ENTSAV.L            = ESR*(YFCTR.L("capital") + GENT.L
711                           - (ENTTAX.L + DEPRECIA.L)) ;
712    YINST.L("labr") = YFCTR.L("labor") - SSTAX.L ;
713    YINST.L("ent")  = YFCTR.L("capital") + GENT.L
714                           - (ENTSAV.L + ENTTAX.L + DEPRECIA.L) ;
715    YINST.L("prop") = YFCTR.L("land") ;
716    YH.L(hh)            = SUM(ins, SINTYH(hh,ins)*YINST.L(ins))
717                           + REMIT.L*RHSH(hh)*EXR.L + HHT.L*THSH(hh) ;
718    TOTHHTAX.L          = SUM(hh, HTAX(hh)*YH.L(hh)) ;
719    HHSAV.L             = SUM(hh, MPS.L(hh)*YH.L(hh)*(1.0 - HTAX(hh))) ;
720
721    *## FINAL DEMAND
722    INT.L(i)    = SUM(j,IO(i,j)*XD.L(j)) ;
723    CD.L(i)     = SUM(hh, CLES(i,hh)*(1.0 - MPS.L(hh))*YH.L(hh)
724                         *(1.0 - HTAX(hh)))/P.L(i) ;
725    GD.L(i)     = GLES(i)*GDTOT.L ;
726    DST.L(i)    = DSTR(i)*XD.L(i) ;
727    FXDINV.L    = INVEST.L - SUM(i, DST.L(i)*P.L(i)) ;
728    DK.L(i)     = (KISH(i)*FXDINV.L)/PK.L(i) ;
729    ID.L(i)     = SUM(j, IMAT(i,j)*DK.L(j)) ;
730    GR.L        = TARIFF.L - NETSUB.L + INDTAX.L + TOTHHTAX.L + SSTAX.L
731                   + ENTTAX.L + FBOR.L*EXR.L ;
732    SAVINGS.L = HHSAV.L + GOVSAV.L + DEPRECIA.L + FSAV.L*EXR.L + ENTSAV.L ;
733
734    *## GNP
735    GNPVA.L     = SUM(i, PVA.L(i)*XD.L(i)) + INDTAX.L + TARIFF.L - NETSUB.L ;
736    RGNP.L      = SUM(i, CD.L(i) + DST.L(i) + ID.L(i) + GD.L(i))
737                   + SUM(ie, (1.0 - TEREAL(ie)) * E.L(ie) )
738                   - SUM(im, (1.0 - TMREAL(im)) * M.L(im) ) ;
739    PINDEX.L    = GNPVA.L/RGNP.L ;
740
741    *## ALTERNATIVELY, SET PINDEX TO THE PRODUCER PRICE INDEX
742    * PINDEX.L = SUM(i, pwts(i)*PX(i)) ;
743
744    DISPLAY YFCTR.L,YINST.L,YH.L,GNPVA.L,RGNP.L,PINDEX.L ;
745    DISPLAY INT.L,CD.L,GD.L,ID.L,DST.L,DK.L ;
746
747    *#################### END VARIABLE SPECIFICATION ####################
748
749    *#### TO CHECK FOR DATA CONSISTENCY, DISPLAY INITIAL SAM
750
751    *#################### SOCIAL ACCOUNTING MATRIX ####################
752
753    SAM("COMMDTY","ACTIVITY")      = SUM(i,(P.L(i)*INT.L(i))) ;
754    SAM("COMMDTY","HOUSEHOLDS")    = SUM(i,(P.L(i)*CD.L(i))) ;
755    SAM("COMMDTY","KACCOUNT")      = SUM(i,(P.L(i)*(DST.L(i)+ID.L(i)))) ;
756    SAM("COMMDTY","GOVT")          = SUM(i,(P.L(i)*GD.L(i))) ;
757    SAM("ACTIVITY","WORLD")        = SUM(i,((EXR.L*PWE.L(i))*E.L(i))) ;
758    SAM("ACTIVITY","COMMDTY")      = SUM(i,  (PX.L(i)*XD.L(i))
```

```
759                                                      - (PE.L(i)*E.L(i)) ) ;
760   SAM("ACTIVITY","GOVT")        = NETSUB.L ;
761   SAM("VALUAD","ACTIVITY")      = SUM(f, YFCTR.L(f)) ;
762   SAM("INSTTNS","VALUAD")       = SUM(f,YFCTR.L(f)) - SSTAX.L ;
763   SAM("INSTTNS","GOVT")         = GENT.L ;
764   SAM("HOUSEHOLDS","INSTTNS")= SUM((ins,hh),SINTYH(hh,ins)*YINST.L(ins));
765   SAM("HOUSEHOLDS","GOVT")      = HHT.L ;
766   SAM("KACCOUNT","INSTTNS")     = ENTSAV.L + DEPRECIA.L ;
767   SAM("KACCOUNT","HOUSEHOLDS") = HHSAV.L ;
768   SAM("KACCOUNT","GOVT")        = GOVSAV.L ;
769   SAM("GOVT","COMMDTY")         = TARIFF.L ;
770   SAM("GOVT","ACTIVITY")        = INDTAX.L ;
771   SAM("GOVT","VALUAD")          = SSTAX.L ;
772   SAM("GOVT","INSTTNS")         = ENTTAX.L ;
773   SAM("GOVT","HOUSEHOLDS")      = TOTHHTAX.L ;
774   SAM("WORLD","COMMDTY")        = SUM(i,((PWM(i)*EXR.L)*M.L(i))) ;
775   SAM("WORLD","HOUSEHOLDS")     = - REMIT.L*EXR.L ;
776   SAM("WORLD","GOVT")           = - FBOR.L*EXR.L ;
777   SAM("WORLD","KACCOUNT")       = - FSAV.L*EXR.L ;
778   SAM("TOTAL","COMMDTY")        = SUM(isam2,SAM(isam2,"COMMDTY")) ;
779   SAM("TOTAL","ACTIVITY")       = SUM(isam2,SAM(isam2,"ACTIVITY")) ;
780   SAM("TOTAL","VALUAD")         = SUM(isam2,SAM(isam2,"VALUAD")) ;
781   SAM("TOTAL","INSTTNS")        = SUM(isam2,SAM(isam2,"INSTTNS")) ;
782   SAM("TOTAL","HOUSEHOLDS")     = SUM(isam2,SAM(isam2,"HOUSEHOLDS")) ;
783   SAM("TOTAL","KACCOUNT")       = SUM(isam2,SAM(isam2,"KACCOUNT")) ;
784   SAM("TOTAL","GOVT")           = SUM(isam2,SAM(isam2,"GOVT")) ;
785   SAM("TOTAL","WORLD")          = SUM(isam2,SAM(isam2,"WORLD")) ;
786   SAM(isam3,"TOTAL")            = SUM(isam2,SAM(isam3,isam2)) ;

787
788   OPTION DECIMALS=2 ;
789   DISPLAY SAM ;
790   OPTION DECIMALS=3 ;
791   *##############################################################
792
793   EQUATIONS
794
795   *################### EQUATION DECLARATION ####################
796
797   *## PRICE BLOCK
798      PMDEF(i)        DEFINITION OF DOMESTIC IMPORT PRICES
799      PEDEF(i)        DEFINITION OF DOMESTIC EXPORT PRICES
800      ABSORPTION(i)   VALUE OF DOMESTIC SALES
801      SALES(i)        VALUE OF DOMESTIC OUTPUT
802      ACTP(i)         DEFINITION OF ACTIVITY PRICES
803      PKDEF(i)        DEFINITION OF CAPITAL GOODS PRICE
804      PINDEXDEF       DEFINITION OF GENERAL PRICE LEVEL
805   *## PRODUCTION BLOCK
806      ACTIVITY(i)     PRODUCTION FUNCTION
807      PROFITMAX(i,f)  FIRST ORDER CONDITIONS FOR PROFIT MAXIMUM
808      INTEQ(i)        TOTAL INTERMEDIATE USES
809      CET(i)          CET FUNCTION
810      CET2(i)         DOMESTIC SALES FOR NONTRADED SECTORS
811      ESUPPLY(i)      EXPORT SUPPLY
812      EDEMAND(i)      EXPORT DEMAND FUNCTIONS
813      ARMINGTON(i)    COMPOSITE GOOD AGGREGATION FUNCTION
814      ARMINGTON2(i)   COMPOSITE GOOD AGG. FOR NONTRADED SECTORS
815      COSTMIN(i)      F.O.C. FOR COST MINIMIZATION OF COMPOSITE GOOD
816   *## INCOME BLOCK
817      YFCTREQ(f)      FACTOR INCOME
818      LABORY          LABOR INCOME
819      PROPY           PROPERTY INCOME
820      ENTY            ENTERPRISE INCOME
821      HHY(hh)         HOUSEHOLD INCOME
822      TARIFFDEF       TARIFF REVENUE
823      INDTAXDEF       INDIRECT TAXES ON DOMESTIC PRODUCTION
824      NETSUBDEF       EXPORT SUBSIDIES
825      TAXSS           SOCIAL SECURITY TAX
826      ETAX            ENTERPRISE TAX
827      HHTAXDEF        TOTAL HOUSEHOLD TAXES COLLECTED BY GOVT.
```

```
828     DEPREQ              DEPRECIATION EXPENDITURE
829     ESAVE              ENTERPRISE SAVINGS
830     HHSAVEQ            HOUSEHOLD SAVINGS
831     GREQ               GOVERNMENT REVENUE
832     TOTSAV             TOTAL SAVINGS
833  *## EXPENDITURE BLOCK
834     CDEQ(i)            PRIVATE CONSUMPTION BEHAVIOR
835     GDEQI(i)           GOVT CONSUMPTION OF COMMODITIES
836     GRUSE              GOVERNMENT SAVINGS
837     DSTEQ(i)           INVENTORY INVESTMENT
838     FIXEDINV           FIXED INVESTMENT NET OF INVENTORY
839     PRODINV(i)         INVESTMENT BY SECTOR OF DESTINATION
840     IEQ(i)             INVESTMENT BY SECTOR OF ORIGIN
841  *## MARKET CLEARING
842     EQUIL(i)           GOODS MARKET EQUILIBRIUM
843     FMEQUIL(f)         FACTOR MARKET EQUILIBRIUM
844     CAEQ               CURRENT ACCOUNT BALANCE (BILL DOLLARS)
845  *  WALRAS             SAVINGS INVESTMENT EQUILIBRIUM
846
847  *## The WALRAS equation is redundant,
848  *## given that the model satisfies Walras' Law.
849  *## In this case, we drop the Savings-Investment balance equation.
850
851  *## GROSS NATIONAL PRODUCT
852     GNPY               TOTAL VALUE ADDED INCLUDING INDTAX
853     GNPR               REAL GNP
854            ;
855
856
857  *###################### EQUATION ASSIGNMENT  ######################
858
859  *## PRICE BLOCK
860
861    PMDEF(im)..     PM(im)  =E= PWM(im)*EXR*(1 + TM(im)) ;
862
863    PEDEF(ie)..     PE(ie)  =E= PWE(ie)*(1 + TE(ie))*EXR ;
864
865    ABSORPTION(i).. P(i)*X(i)   =E= PD(i)*XXD(i) + (PM(i)*M(i))$im(i) ;
866
867    SALES(i)..      PX(i)*XD(i) =E= PD(i)*XXD(i) + (PE(i)*E(i))$ie(i) ;
868
869    ACTP(i)..       PVA(i) =E= PX(i)*(1.0-ITAX(i)) - SUM(j,IO(j,i)*P(j)) ;
870
871    PKDEF(i)..      PK(i)   =E= SUM(J, P(j)*IMAT(j,i)) ;
872
873    PINDEXDEF..     PINDEX  =E= GNPVA/RGNP ;
874
875  *## PRODUCTION BLOCK
876
877    ACTIVITY(i)..   XD(i)   =E= AD(i)*PROD(f$ALPHA(i,f),
878                                   FDSC(i,f)**ALPHA(i,f)) ;
879
880    PROFITMAX(i,f)$WFDIST(i,f)..  WF(f)*WFDIST(i,f)*FDSC(i,f) =E=
881                                   XD(i)*PVA(i)*ALPHA(i,f) ;
882
883    INTEQ(i)..      INT(i)  =E= SUM(J, IO(i,j)*XD(j));
884
885    CET(ie)..       XD(ie)  =E= AT(ie)*(GAMMA(ie)*E(ie)**RHOT(ie) +
886                      (1-GAMMA(ie))*XXD(ie)**RHOT(ie))**(1/RHOT(ie)) ;
887
888    CET2(ien)..     XD(ien) =E= XXD(ien) ;
889
890    ESUPPLY(ie)..   E(ie)   =E= XXD(ie)*(PE(ie)/PD(ie)*(1 - GAMMA(ie))
891                        /GAMMA(ie))**(1/(RHOT(ie)-1)) ;
892
893    EDEMAND(ied)..  E(ied)  =E= ECONST(ied)*((PWE(ied)/PWSE(ied))
894                                        **(-RHOE(ied))) ;
895
896    ARMINGTON(im).. X(im)   =E= AC(im)*(DELTA(im)*M(im)**(-RHOC(im)) +
```

```
897                        (1 - DELTA(im))*XXD(im)**(-RHOC(im)))**(-1/RHOC(im)) ;
898
899    ARMINGTON2(imn)..   X(imn) =E= XXD(imn) ;
900
901    COSTMIN(im)..    M(im)/XXD(im) =E= (PD(im)/PM(im)*DELTA(im)/
902                                    (1 - DELTA(im)))**(1/(1 + RHOC(im))) ;
903
904    *## INCOME BLOCK
905
906    YFCTREQ(f)..     YFCTR(f) =E= SUM(i, WF(f)*WFDIST(i,f)*FDSC(i,f));
907
908    LABORY..         YINST("labr") =E= YFCTR("labor") - SSTAX ;
909
910    PROPY..          YINST("prop") =E= YFCTR("land") ;
911
912    ENTY..           YINST("ent")  =E= YFCTR("capital") + GENT
913                                    - (ENTSAV + ENTTAX + DEPRECIA) ;
914
915    HHY(hh)..        YH(hh) =E= SUM(ins, SINTYH(hh,ins)*YINST(ins))
916                                    + REMIT*RHSH(hh)*EXR + HHT*THSH(hh) ;
917
918    TARIFFDEF..      TARIFF =E= SUM(im, TM(im)*M(im)*PWM(im))*EXR ;
919
920    INDTAXDEF..      INDTAX =E= SUM(i, ITAX(i)*PX(i)*XD(i)) ;
921
922    NETSUBDEF..      NETSUB =E= SUM(ie, TE(ie)*E(ie)*PWE(ie))*EXR ;
923
924    TAXSS..          SSTAX  =E= SSTR*YFCTR("labor") ;
925
926    ETAX..           ENTTAX =E= ETR*(YFCTR("CAPITAL") - DEPRECIA + GENT) ;
927
928    HHTAXDEF..       TOTHHTAX =E= SUM(hh, HTAX(hh)*YH(hh)) ;
929
930    DEPREQ..         DEPRECIA =E= SUM(i, DEPR(i)*PK(i)*FDSC(I,"capital")) ;
931
932    ESAVE..          ENTSAV =E= ESR*(YFCTR("CAPITAL")+GENT-ENTTAX-DEPRECIA);
933
934    HHSAVEQ..        HHSAV  =E= SUM(hh, MPS(hh)*YH(hh)*(1 - HTAX(hh))) ;
935
936    GREQ..           GR     =E= TARIFF - NETSUB + INDTAX +TOTHHTAX +
937                                    SSTAX + ENTTAX + FBOR*EXR ;
938
939    TOTSAV..      SAVINGS =E= HHSAV + GOVSAV + DEPRECIA + FSAV*EXR + ENTSAV ;
940
941    *## EXPENDITURE BLOCK
942
943    CDEQ(i)..        P(i)*CD(i) =E= SUM(hh, CLES(i,hh)*(1-MPS(hh))*YH(hh)
944                                    *(1-HTAX(hh))) ;
945
946    GDEQI(i)..       GD(i)  =E= GLES(i)*GDTOT ;
947
948    GRUSE..          GR     =E= SUM(i, P(i)*GD(i)) + GOVSAV + GENT + HHT ;
949
950    DSTEQ(i)..       DST(i) =E= DSTR(i)*XD(i) ;
951
952    FIXEDINV..       FXDINV =E= INVEST - SUM(i, DST(i)*P(i)) ;
953
954    PRODINV(i)..     PK(i)*DK(i) =E= KISH(i)*FXDINV ;
955
956    IEQ(i)..         ID(i)  =E= SUM(J, IMAT(i,j)*DK(j));
957
958    *## MARKET CLEARING
959
960    EQUIL(i)..       X(i)   =E= INT(i) + CD(i) + GD(i) + ID(i) + DST(i) ;
961
962    FMEQUIL(f)..     SUM(i, FDSC(i,f)) =E= FS(f) ;
963
964    CAEQ..           SUM(im, PWM(im)*M(im)) =E= SUM(ie, PWE(ie)*E(ie))
965                                    + FSAV + REMIT + FBOR ;
```

```
966
967    *WALRAS..          SAVINGS =E= INVEST ;
968
969    *## GROSS NATIONAL PRODUCT
970
971    GNPY..        GNPVA =E= SUM(i,PVA(i)*XD(i)) + INDTAX + TARIFF - NETSUB ;
972
973    GNPR..        RGNP =E= SUM(i,CD(i) + DST(i) + ID(i) + GD(i))
974                            + SUM(ie,(1.0 - TEREAL(ie)) * E(ie) )
975                            - SUM(im,(1.0 - TMREAL(im)) * M(im) ) ;
976
977    *#### ADDITIONAL RESTRICTIONS CORRESPONDING TO EQUATIONS
978    *# PMDEF, PEDEF, EDEMAND, ESUPPLY, COSTMIN, AND PROFITMAX
979    *# FOR NON-TRADED SECTORS AND SECTORS WITH FIXED WORLD EXPORT PRICES
980
981    PM.FX(imn)   = PMO(imn) ;
982    PE.FX(ien)   = PEO(ien) ;
983    PWE.FX(iedn) = PWE.L(iedn) ;
984    E.FX(ien)    = 0;
985    M.FX(imn)    = 0;
986    FDSC.FX(i,f)$(WFDIST(i,f) EQ 0) = 0 ;
987
988    *#### VARIABLE BOUNDS
989    *These are included to improve algorithm performance.  They are not
990    *necessary for model specification.
991    P.LO(i)    = 0.0 ;  PD.LO(i)  = 0.0 ;  PM.LO(im) = 0.0 ;
992    PK.LO(i)   = 0.0 ;  PX.LO(i)  = 0.0 ;  X.LO(i)   = 0.0 ;
993    XD.LO(i)   = 0.0 ;  M.LO(im)  = 0.0 ;  XXD.LO(i) = 0.0 ;
994    WF.LO(f)   = 0.0 ;  INT.LO(i) = 0.0 ;  E.LO(ie)  = 0.0 ;
995    FDSC.LO(i,f)$(FDSC.L(i,f) NE 0) = 0.0 ;
996    PVA.LO(i) = 0.0 ;
997
998    *######################### MODEL CLOSURE #########################
999
1000   *## FOREIGN EXCHANGE MARKET CLOSURE
1001   * In this version, the balance of trade (current account balance) is
1002   * fixed exogenously and the exchange rate is the equilibrating variable.
1003
1004   *  EXR.FX      = EXR.L ;
1005      FSAV.FX     = FSAV.L ;
1006      REMIT.FX    = REMIT.L ;
1007      FBOR.FX     = FBOR.L ;
1008
1009   *## INVESTMENT-SAVINGS CLOSURE
1010   * This version specifies neoclassical closure.  Aggregate investment is
1011   * determined by aggregate savings; the model is savings driven.
1012
1013      MPS.FX(hh) = MPS.L(hh) ;
1014   *  INVEST.FX  = INVEST.L ;
1015
1016   *## EXOGENOUS GOVT EXPENDITURE
1017   *## AND GOVT CLOSURE RULE
1018   * Real government spending (GDTOT) is fixed exogenously.  The government
1019   * deficit (GOVSAV) is determined residually.
1020
1021      GDTOT.FX    = GDTOT.L ;
1022      GENT.FX     = GENT.L ;
1023      HHT.FX      = HHT.L ;
1024   *  GOVSAV.FX = GOVSAV.L ;
1025
1026   *## FACTOR MARKET CLOSURE
1027   * In this version, all factors, including capital, are mobile.
1028   * Commented equations allow a version with fixed wage for labor.
1029   * The model then solves for aggregate employment.
1030
1031      FS.FX(f)        = FS.L(f) ;
1032   *  WF.FX("labor") = WF.L("labor") ;
1033   *  FS.LO("labor") = -inf ;
1034   *  FS.UP("labor") = +inf ;
```

```
1035
1036   *## NUMERAIRE PRICE INDEX
1037   *In this case, the GNP deflator.
1038
1039      PINDEX.FX = PINDEX.L ;
1040
1041
1042   *######################### END OF MODEL #########################
1043
1044    OPTIONS ITERLIM=1000,LIMROW=0,LIMCOL=0,SOLPRINT=OFF;
1045
1046    MODEL US82 /ALL/ ;
1047
1048    SOLVE US82 MAXIMIZING RGNP USING NLP;
1049
1050
1051   *#################### SOLUTION REPORTS AND OUTPUT ####################
1052   *#### THREE REPORT AND OUTPUT BLOCKS
1053   *## 1) TABLES OF RESULTS FOR VARIABLES IN MODEL
1054   *## 2) TABLES OF RESULTS FOR DISPLAY
1055   *## 3) TABLES OF RESULTS FOR RESTART SOLUTION RATIO TABLES
1056   *## USE $ONTEXT AND $OFFTEXT TO TURN OFF REPORTS NOT WANTED.
1057   *####################################################################
1058
1059   *#### 1) TABLES OF RESULTS FOR VARIABLES IN THE MODEL
1060
1061   *## MACRO AGGREGATE RESULTS
1062    SCALRES("EXR")      = EXR.L ;
1063    SCALRES("PINDEX")   = PINDEX.L ;
1064    SCALRES("RGNP")     = RGNP.L ;
1065    SCALRES("GNPVA")    = GNPVA.L ;
1066
1067    SCALRES("INVEST")   = INVEST.L ;
1068    SCALRES("FXDINV")   = FXDINV.L ;
1069    SCALRES("GDTOT")    = GDTOT.L ;
1070    SCALRES("GR")       = GR.L ;
1071
1072    SCALRES("SSTAX")    = SSTAX.L ;
1073    SCALRES("TARIFF")   = TARIFF.L ;
1074    SCALRES("INDTAX")   = INDTAX.L ;
1075    SCALRES("ENTTAX")   = ENTTAX.L ;
1076    SCALRES("TOTHHTAX") = TOTHHTAX.L ;
1077    SCALRES("NETSUB")   = NETSUB.L ;
1078
1079    SCALRES("REMIT")    = REMIT.L ;
1080    SCALRES("GENT")     = GENT.L ;
1081    SCALRES("HHT")      = HHT.L ;
1082    SCALRES("FBOR")     = FBOR.L ;
1083
1084    SCALRES("SAVINGS")  = SAVINGS.L ;
1085    SCALRES("ENTSAV")   = ENTSAV.L ;
1086    SCALRES("DEPRECIA") = DEPRECIA.L ;
1087    SCALRES("HHSAV")    = HHSAV.L ;
1088    SCALRES("GOVSAV")   = GOVSAV.L ;
1089    SCALRES("FSAV")     = FSAV.L ;
1090
1091
1092   *## FACTOR OF PRODUCTION RESULTS
1093    FCTRES1(i,f)        = FDSC.L(i,f) ;
1094
1095   *## TABLE FCTRES2(*,f) MISCELLANEOUS FACTOR VARIABLE RESULTS ;
1096    SET IFVAR /WF, FS, YFCTR/ ;
1097    PARAMETER FCTRES2(ifvar,f) MISCELLANEOUS FACTOR VARIABLE RESULTS ;
1098    FCTRES2("WF",f)     = WF.L(f) ;
1099    FCTRES2("FS",f)     = FS.L(f) ;
1100    FCTRES2("YFCTR",f)  = YFCTR.L(f) ;
1101
1102   *## SECTORAL PRICE AND QUANTITY RESULTS
1103    SECTRES("P",i)   = P.L(i) ;
```

```
1104   SECTRES("PD",i)  = PD.L(i) ;
1105   SECTRES("PE",i)  = PE.L(i) ;
1106   SECTRES("PK",i)  = PK.L(i) ;
1107   SECTRES("PM",i)  = PM.L(i) ;
1108   SECTRES("PVA",i) = PVA.L(i) ;
1109   SECTRES("PWE",i) = PWE.L(i) ;
1110   SECTRES("PX",i)  = PX.L(i) ;
1111
1112   SECTRES("X",i)   = X.L(i) ;
1113   SECTRES("XD",i)  = XD.L(i) ;
1114   SECTRES("XXD",i) = XXD.L(i) ;
1115   SECTRES("E",i)   = E.L(i) ;
1116   SECTRES("M",i)   = M.L(i) ;
1117   SECTRES("INT",i) = INT.L(i) ;
1118   SECTRES("CD",i)  = CD.L(i) ;
1119   SECTRES("GD",i)  = GD.L(i) ;
1120   SECTRES("ID",i)  = ID.L(i) ;
1121   SECTRES("DST",i) = DST.L(i) ;
1122   SECTRES("DK",i)  = DK.L(i) ;
1123
1124   *## INSTITUTIONAL RESULTS
1125   *## TABLE INSRES(*,ins) INSTITUTIONAL INCOME RESULTS
1126    SET INSVAR /YINST/ ;
1127    PARAMETER INSRES(insvar,ins) INSTITUTIONAL INCOME RESULTS ;
1128    INSRES("YINST",ins) = YINST.L(ins) ;
1129
1130   *## HOUSEHOLD RESULTS
1131   *## TABLE HHRES(*,hh) MISCELLANEOUS HOUSEHOLD RESULTS
1132    SET HHVAR /MPS, YH/ ;
1133    PARAMETER HHRES(hhvar,hh) MISCELLANEOUS HOUSEHOLD RESULTS ;
1134    HHRES("MPS",hh)      = MPS.L(hh) ;
1135    HHRES("YH",hh)       = YH.L(hh) ;
1136
1137    option decimals = 6 ;
1138    DISPLAY SCALRES, FCTRES1, FCTRES2, SECTRES, INSRES, HHRES ;
1139    option decimals = 3 ;
1140
1141   *###############################################################
1142
1143   *#### 2) TABLES OF RESULTS FOR DISPLAY
1144
1145   *## DEFINE SETS FOR SOLUTION REPORT TABLES ####
1146   * For GNP TABulations
1147
1148    SET ignp  rows        /consmpt,Investment,Inventory,Government,
1149                           Exports,Imports,GNP /
1150        ignp1(ignp)       /gnp/
1151        ignp2(ignp)
1152        jgnp  columns     /nominal
1153                           real
1154                           nomshare
1155                           realshare
1156                           deflator / ;
1157    ignp2(ignp) = NOT ignp1(ignp) ;
1158
1159    PARAMETER gnptab(ignp,jgnp)  GNP ACCOUNTS ;
1160    PARAMETER gnptab2(i,jgnp)    SECTORAL VALUE ADDED ;
1161    PARAMETER sumgnp(jgnp)       AGGREGATE GNP;
1162    PARAMETER gnpratio           GNP value added correction factor ;
1163
1164   * for ABSORB
1165    set rar  rows    / ag,non-ag,total /
1166        rac  columns / GNP,C,I,G,E,M,NETE-M,T-G,ABSORB /
1167    PARAMETER ABSORB(rar,rac)    ABSORPTION TABLE (REAL) ;
1168
1169   * for FACTORS
1170    set rf / yf,yfcap,profit,rental,rdist,wdcap,
1171            yflabor,wdlabor,yfland,wdland,pint,intinp /
1172    PARAMETER FACTORS(i,rf)      FACTOR RETURNS DISTRIBUTIVE PARAMETERS ;
```

60

```
1173
1174    * for COEFFS (shift and share coefficients)
1175      set rc / ALPHAL,ALPHAC,ALPHAP,RMD,DELTA,AD /
1176      PARAMETER COEFFS(i,rc)        SHIFT,SHARE AND DISTRIBUTIVE PARAMETERS ;
1177
1178    *## DEFINE EXTRA PARAMETERS FOR SOLUTION REPORT TABLES ####
1179
1180      PARAMETERS
1181            agtotfd        agricultural terms of trade
1182            agtotva        ag terms of trade value added
1183            agtote         ag terms of trade world export price
1184            agtotm         ag terms of trade world import price
1185            avgprofit      average profit rate
1186            avgwf          average factor price current weights
1187            bot            nominal balance of trade
1188            botr           real balance of trade
1189            colind         cost of living index
1190            esum           real exports
1191            exrind         real exchange rate index
1192            hold1          holds value for end calculation
1193            indhold        holds value for end calculation
1194            intinp(i)      intermediate input demand by sector i
1195            intinpn(i)     nominal intermediate input demand by sector i
1196            msum           real imports
1197            ncdtot         nominal cdtot
1198            nex            nominal exports
1199            nim            nominal imports
1200            ngdtot         nominal govt demand
1201            ngnp           nominal GNP
1202            pnagind        nonag price index
1203            pagind         ag price index
1204            pmind          domestic import price index
1205            peind          domestic export price index
1206            pweind         world export price index
1207            pwmind         world import price index
1208            psav           private savings
1209            pxind          producer price index
1210            pdind          domestic supply price index
1211            pind           composite good price index
1212            pint(i)        cost per unit of intermediate inputs
1213            profit(i)      profit rate
1214            rdist(i)       capital rental proportionality factor
1215            rental(i)      rental rate of capital
1216            shconsump      consumption share of nominal gnp
1217            shinvest       investment share of nominal gnp
1218            shex           export share of nominal gnp
1219            shim           import share of nominal gnp
1220            shgdtot        govt consumption share of nominal gnp
1221            shbot          balance of trade share of nominal gnp
1222            shfsav         foreign saving share of investment
1223            shgsav         government saving share of investment
1224            shpsav         private saving share of investment
1225            valadd(i)      value added at market price
1226            sectory(i)     value added at factor cost
1227            wtd(i)         base year wt domestic in total domestic sales
1228            wtm(i)         base year wt of imports in total trade
1229            wtx(i)         base year wt of exports in total trade
1230            yf(i,f)        factor income
1231                   ;
1232
1233    *#### SPECIFY EXTRA PARAMETERS FOR SOLUTION REPORT TABLES ####
1234
1235    *## AG TERMS OF TRADE ##
1236    pagind      = SUM(iag,px.l(iag)*xd.l(iag))/SUM(iag,xd.l(iag));
1237    pnagind     = SUM(iagn,px.l(iagn)*xd.l(iagn))/SUM(iagn,xd.l(iagn));
1238    agtotfd     = 100*pagind/pnagind;
1239
1240    pagind      = SUM(iag,pva.l(iag)*xd.l(iag))/SUM(iag,xd.l(iag));
1241    pnagind     = SUM(iagn,pva.l(iagn)*xd.l(iagn))/SUM(iagn,xd.l(iagn));
```

61

```
1242   agtotva    = 100*pagind/pnagind;
1243
1244   pagind     = SUM(iag,pwe.l(iag)*e.l(iag))/SUM(iag,e.l(iag));
1245   pnagind    = SUM(iagn,pwe.l(iagn)*e.l(iagn))/SUM(iagn,e.l(iagn));
1246   agtote     = 100*pagind/pnagind;
1247   pagind     = SUM(iag,pwm(iag)*m.l(iag))/SUM(iag,m.l(iag));
1248   pnagind    = SUM(iagn,pwm(iagn)*m.l(iagn))/SUM(iagn,m.l(iagn));
1249   agtotm     = 100*pagind/pnagind;
1250
1251   DISPLAY agtotfd, agtotva, agtotm, agtote ;
1252
1253   *## MACRO BALANCES ##
1254   ncdtot     = SUM(i,cd.l(i)*p.l(i));
1255   ngdtot     = SUM(i,gd.l(i)*p.l(i));
1256   ngnp       = SUM(i,p.l(i)*(cd.l(i) + dst.l(i) + id.l(i) + gd.l(i))
1257                      + pe.l(i)*e.l(i) - pwm(i)*exr.l*m.l(i));
1258   nex        = SUM(ie,e.l(ie)*exr.l*pwe.l(ie));
1259   nim        = SUM(im,m.l(im)*exr.l*pwm(im));
1260   bot        = nex-nim;
1261   botr       = SUM(i,e.l(i)) - SUM(i,m.l(i));
1262   esum       = SUM(i,e.l(i));
1263   msum       = SUM(i,m.l(i));
1264   psav       = invest.l - fsav.l - govsav.l;
1265   shbot      = 100*bot/gnpva.l;
1266   shconsump  = 100*ncdtot/gnpva.l;
1267   shex       = 100*nex/gnpva.l;
1268   shfsav     = 100*fsav.l/invest.l;
1269   shim       = 100*nim/gnpva.l;
1270   shinvest   = 100*invest.l/gnpva.l;
1271   shgdtot    = 100*ngdtot/gnpva.l;
1272   shgsav     = 100*govsav.l/invest.l;
1273   shpsav     = 100*psav/invest.l;
1274
1275   DISPLAY bot,botr,nex,esum,nim,msum,shconsump,shinvest,
1276              shgdtot,shex,shim,shbot,shfsav,shgsav,shpsav;
1277
1278   *## INDEXES ##
1279   * Note that cost of living index (COLIND) is the simple average over
1280   * households.  CARD(hh) is the "cardinal" function which counts number
1281   * of entries in the set.
1282
1283   COLIND     = SUM(i,p.l(i)*(SUM(hh,cles(i,hh))))*100/CARD(hh);
1284   WTD(i)     = XXD0(i)/SUM(j,XXD0(j)) ;
1285   WTM(i)     = M0(i)/SUM(j,(M0(j)+E0(j))) ;
1286   WTX(i)     = E0(i)/SUM(j,(M0(j)+E0(j))) ;
1287   EXRIND     = SUM(i,WTD(i)*PD.L(i))
1288                      /SUM(i,(WTM(i)*PM.L(i))+(WTX(i)*PE.L(i)))*100 ;
1289   pdind      = SUM(i,xxd0(i)*pd.l(i))/SUM(j,xxd0(j))*100;
1290   peind      = SUM(i,e0(i)*pe.l(i))/SUM(j,e0(j))*100;
1291   pind       = SUM(i,x0(i)*p.l(i))/SUM(j,x0(j))*100;
1292   pmind      = SUM(i,m0(i)*pm.l(i))/SUM(j,m0(j))*100;
1293   pweind     = SUM(i,e0(i)*pwe.l(i))/SUM(i,e0(i))*100;
1294   pwmind     = SUM(i,m0(i)*pwm(i))/SUM(i,m0(i))*100;
1295   pxind      = SUM(i,pwts(i)*px.l(i))*100 ;
1296
1297   DISPLAY colind,exrind,ngnp,pdind,pind,peind,pmind,pweind,pwmind,pxind;
1298
1299   *#### SPECIFY SOLUTION REPORT TABLES ####
1300
1301   *## GNP Tables ##
1302
1303   * Note treatment of tariffs.
1304   * In U.S. NIPA, tariffs are included in the service sector.
1305   * In the U.N. SNA, tariffs are treated separately.
1306   * Treatment below follows U.S. NIPA practice.
1307   * Note that real GNP from expenditure side provides the control total,
1308   * and sectoral real value addeds are adjusted
1309   * to match total using gnpratio.
1310
```

```
1311   gnptab("consmpt","nominal")        = SUM(i,p.l(i)*cd.l(i)) ;
1312   gnptab("consmpt","real")           = SUM(i,cd.l(i));
1313   gnptab("investment","nominal")     = SUM(i,p.l(i)*id.l(i));
1314   gnptab("investment","real")        = SUM(i,id.l(i)) ;
1315   gnptab("inventory","nominal")      = SUM(i,p.l(i)*dst.l(i)) ;
1316   gnptab("inventory","real")         = SUM(i,dst.l(i)) ;
1317   gnptab("government","nominal")     = SUM(i,p.l(i)*gd.l(i)) ;
1318   gnptab("government","real")        = SUM(i,gd.l(i)) ;
1319   gnptab("exports","nominal")        = SUM(i,pwe.l(i)*e.l(i))*exr.l ;
1320   gnptab("exports","real")           = SUM(i,(1.0 - tereal(i))*e.l(i)) ;
1321   gnptab("imports","nominal")        = -SUM(i,pwm(i)*m.l(i))*exr.l ;
1322   gnptab("imports","real")           = -SUM(i,(1.0 - tmreal(i))*m.l(i)) ;
1323   gnptab("gnp","nominal")         = SUM(ignp2,gnptab(ignp2,"nominal")) ;
1324   gnptab("gnp","real")            = SUM(ignp2,gnptab(ignp2,"real")) ;
1325   gnptab(ignp,"nomshare")         = 100.*gnptab(ignp,"nominal")
1326                                           /gnptab("gnp","nominal") ;
1327   gnptab(ignp,"realshare")        = 100.*gnptab(ignp,"real")
1328                                                /gnptab("gnp","real") ;
1329   gnptab(ignp,"deflator")         = 100.*gnptab(ignp,"nominal")
1330                                                /gnptab(ignp,"real") ;
1331
1332   gnptab2(i,"nominal")           = pva.l(i)*xd.l(i) + itax(i)*px.l(i)*xd.l(i)
1333                                     - te(i)*pwe.l(i)*e.l(i)*exr.l ;
1334   gnptab2("service","nominal") = gnptab2("service","nominal") + tariff.l;
1335   gnptab2(i,"real")             = var0(i)*xd.l(i) ;
1336   gnptab2("service","real") = gnptab2("service","real")
1337                                     + SUM(i,tmreal(i)*m.l(i));
1338   sumgnp("nominal")            = SUM(i,gnptab2(i,"nominal")) ;
1339   sumgnp("real")               = SUM(i,gnptab2(i,"real")) ;
1340   gnpratio                     = gnptab("gnp","real")/sumgnp("real") ;
1341   gnptab2(i,"real")            = gnpratio*gnptab2(i,"real") ;
1342   sumgnp("real")               = SUM(i,gnptab2(i,"real")) ;
1343   gnptab2(i,"nomshare")        = 100*gnptab2(i,"nominal")/sumgnp("nominal") ;
1344   gnptab2(i,"realshare")       = 100*gnptab2(i,"real")/sumgnp("real") ;
1345   sumgnp("nomshare")           = SUM(i,gnptab2(i,"nomshare")) ;
1346   sumgnp("realshare")          = SUM(i,gnptab2(i,"realshare")) ;
1347   gnptab2(i,"deflator")        = 100.*gnptab2(i,"nominal")/gnptab2(i,"real");
1348
1349   DISPLAY  GNPTAB, GNPTAB2, SUMGNP, GNPRATIO ;
1350
1351   *## REPORT ABSORPTION ##
1352   absorb("ag","c")             = SUM(iag,CD.L(iag)) ;
1353   absorb("non-ag","c")         = SUM(iagn,CD.l(iagn)) ;
1354   absorb("total","c")          = SUM(i,CD.l(i)) ;
1355   absorb("ag","i")             = SUM(iag,ID.L(iag)) ;
1356   absorb("non-ag","i")         = SUM(iagn,ID.L(iagn)) ;
1357   absorb("total","i")          = SUM(i,ID.L(i)) ;
1358   absorb("ag","g")             = SUM(iag,GD.L(iag)) ;
1359   absorb("non-ag","g")         = SUM(iagn,GD.L(iagn)) ;
1360   absorb("total","g")          = SUM(i,GD.L(i)) ;
1361   absorb("ag","E")             = SUM(iag,E.L(iag)) ;
1362   absorb("non-ag","E")         = SUM(iagn,E.L(iagn)) ;
1363   absorb("total","E")          = SUM(i,E.L(i)) ;
1364   absorb("ag","M")             = SUM(iag,M.L(iag)) ;
1365   absorb("non-ag","M")         = SUM(iagn,M.L(iagn)) ;
1366   absorb("total","M")          = SUM(i,M.L(i)) ;
1367   absorb("ag","NETE-M")        = SUM(iag,E.L(iag))-SUM(iag,M.L(iag)) ;
1368   absorb("non-ag","NETE-M")    = SUM(iagn,E.L(iagn))-SUM(iagn,M.L(iagn)) ;
1369   absorb("total","NETE-M")     = esum - msum ;
1370   absorb("total","T-G")        = govsav.L ;
1371   absorb("ag","GNP")           = SUM(iag,cd.l(iag)+dst.l(iag)+id.l(iag)
1372                                      +gd.l(iag)+e.l(iag)-m.l(iag)) ;
1373   absorb("non-ag","gnp")       = rgnp.l - absorb("ag","gnp") ;
1374   absorb("total","gnp")        = rgnp.l ;
1375   absorb("ag","absorb")        = SUM(iag,cd.l(iag)+id.l(iag)+gd.l(iag)) ;
1376   absorb("non-ag","absorb")    = SUM(iagn,cd.l(iagn)+id.l(iagn)+gd.l(iagn));
1377   absorb("total","absorb")     = SUM(i,cd.l(i)+id.l(i)+gd.l(i)) ;
1378
1379   DISPLAY ABSORB ;
```

```
1380
1381   *### calculate and report selected parameters and coefficients #########
1382     INTINP(j)  = sum(i, IO(i,j)*XD.L(j)) ;
1383     INTINPN(j) = sum(i, P.L(i)*IO(i,j)*XD.L(j)) ;
1384     PINT(i)    = SUM(J, IO(J,i)*P.L(j)) ;
1385     YF(i,f)    = WFDIST(i,f)*WF.L(f)*FDSC.L(i,f) ;
1386     PROFIT(i)  = (WFDIST(i,"capital")*WF.L("capital")*FDSC.L(i,"capital"))
1387                   /(FDSC.L(i,"capital")*PK.L(i)) ;
1388     AVGPROFIT  = SUM(I, WFDIST(i,"capital")*WF.L("capital")
1389                   *FDSC.L(i,"capital"))/SUM(I, FDSC.L(i,"capital")*PK.L(i));
1390     AVGWF(f)   = YFCTR.L(f)/FS.L(f) ;
1391     RENTAL(i)  = (WFDIST(i,"capital")*WF.L("capital")*FDSC.L(i,"capital"))
1392                   /FDSC.L(i,"capital") ;
1393     RDIST(i)   = RENTAL(i)/AVGWF("capital") ;
1394     VALADD(i)  = (PVA.L(i)+(ITAX(i)*PX.L(i)))*XD.L(i);
1395     SECTORY(i) = (PVA.L(i))*XD.L(i);
1396     RMD(i)     = M.L(i)/XXD.L(i) ;
1397
1398   DISPLAY AVGWF,AVGPROFIT,VALADD,SECTORY ;
1399
1400     FACTORS(i,"YF")      = SUM(f,YF(i,f)) ;
1401     FACTORS(i,"YFCAP")   = YF(i,"capital") ;
1402     FACTORS(i,"PROFIT")  = PROFIT(i) ;
1403     FACTORS(i,"RENTAL")  = RENTAL(i) ;
1404     FACTORS(i,"RDIST")   = RDIST(i) ;
1405     FACTORS(i,"WDCAP")   = WFDIST(i,"CAPITAL") ;
1406     FACTORS(i,"YFLABOR") = YF(i,"LABOR") ;
1407     FACTORS(i,"WDLABOR") = WFDIST(i,"LABOR") ;
1408     FACTORS(i,"YFLAND")  = YF(i,"LAND") ;
1409     FACTORS(i,"WDLAND")  = WFDIST(i,"LAND") ;
1410     FACTORS(i,"PINT")    = PINT(i) ;
1411     FACTORS(i,"INTINP")  = INTINP(i) ;
1412
1413
1414     COEFFS(i,"ALPHAL")   = ALPHA(i,"LABOR") ;
1415     COEFFS(i,"ALPHAP")   = ALPHA(i,"LAND") ;
1416     COEFFS(i,"ALPHAC")   = ALPHA(i,"CAPITAL") ;
1417     COEFFS(i,"RMD")      = RMD(i) ;
1418     COEFFS(i,"DELTA")    = DELTA(i) ;
1419     COEFFS(i,"AD")       = AD(i) ;
1420
1421   DISPLAY FACTORS, COEFFS ;
1422
1423
1424   *###########################################################################
1425
1426
1427   *#### 3) TABLES OF RESULTS FOR RESTART SOLUTION RATIO TABLES
1428
1429   *#### DEFINE SETS FOR RESTART SOLUTION RATIO TABLES ####
1430
1431   * for SCALRES1,SCALRES2,RSCALE
1432     SET sc / EXR,    PINDEX, RGNP,   GNPVA,  INVEST,   FXDINV,   GDTOT,
1433              GR,     SSTAX,  TARIFF, INDTAX, ENTTAX,   TOTHHTAX, NETSUB,
1434              REMIT,  GENT,   HHT,    FBOR,   SAVINGS,  ENTSAV,   DEPRECIA,
1435              HHSAV, GOVSAV, FSAV / ;
1436     PARAMETER SCALRES1(sc)       AGGREGATE VARIABLES ;
1437     PARAMETER SCALRES2(sc)       RESTART SCALAR RESULTS ;
1438     PARAMETER RSCALE(sc)         PERCENT CHANGE FROM BASE SCALARS ;
1439
1440   * for PRICRES
1441     SET rp / PX, PVA, PE, PWE, PM, PWM, PD, P, PROFIT, RENTAL, PINT / ;
1442     PARAMETER PRICRES1(i,rp)    PRICE RESULTS BY SECTOR ;
1443     PARAMETER PRICRES2(i,rp)    RESTART PRICE RESULTS ;
1444     PARAMETER RPRICE(i,rp)      PERCENT CHANGE FROM BASE PRICE RESULTS ;
1445
1446   * for QUANTRES
1447     SET rq / XD, VALADD, SECTORY, E, M, LABOR, CAPITAL, LAND, X, XXD / ;
1448     PARAMETER QUANTRES1(i,rq)  QUANTITY RESULTS BY SECTOR ;
```

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1449     PARAMETER QUANTRES2(i,rq)   RESTART QUANTITY RESULTS ;
1450     PARAMETER RQUANT(i,rq)      PERCENT CHANGE FROM BASE QUANTITY RESULTS ;
1451
1452   *#### SPECIFY TABLES FOR RESTART RATIO SOLUTION REPORTS ####
1453
1454     PRICRES1(i,"PX")        = PX.L(i) ;
1455     PRICRES1(i,"PVA")       = PVA.L(i) ;
1456     PRICRES1(i,"PE")        = PE.L(i) ;
1457     PRICRES1(i,"PWE")       = PWE.L(i) ;
1458     PRICRES1(i,"PM")        = PM.L(i) ;
1459     PRICRES1(i,"PWM")       = PWM(i) ;
1460     PRICRES1(i,"PD")        = PD.L(i) ;
1461     PRICRES1(i,"P")         = P.L(i) ;
1462     PRICRES1(i,"PROFIT")    = PROFIT(i) ;
1463     PRICRES1(I,"RENTAL")    = RENTAL(i) ;
1464     PRICRES1(I,"PINT")      = PINT(i) ;
1465
1466     QUANTRES1(i,"XD")       = XD.L(i) ;
1467     QUANTRES1(i,"VALADD")   = VALADD(i) ;
1468     QUANTRES1(i,"SECTORY")  = SECTORY(i) ;
1469     QUANTRES1(i,"E")        = E.L(i) ;
1470     QUANTRES1(i,"M")        = M.L(i) ;
1471     QUANTRES1(i,"LABOR")    = FDSC.L(i,"LABOR") ;
1472     QUANTRES1(i,"CAPITAL")  = FDSC.L(i,"capital") ;
1473     QUANTRES1(i,"LAND")     = FDSC.L(i,"LAND") ;
1474     QUANTRES1(i,"X")        = X.L(i) ;
1475     QUANTRES1(i,"XXD")      = XXD.L(i) ;
1476
1477   *## MACRO AGGREGATE RESULTS
1478     SCALRES1("EXR")     = EXR.L ;
1479     SCALRES1("PINDEX")  = PINDEX.L ;
1480     SCALRES1("RGNP")    = RGNP.L ;
1481     SCALRES1("GNPVA")   = GNPVA.L ;
1482
1483     SCALRES1("INVEST")  = INVEST.L ;
1484     SCALRES1("FXDINV")  = FXDINV.L ;
1485     SCALRES1("GDTOT")   = GDTOT.L ;
1486     SCALRES1("GR")      = GR.L ;
1487
1488     SCALRES1("SSTAX")   = SSTAX.L ;
1489     SCALRES1("TARIFF")  = TARIFF.L ;
1490     SCALRES1("INDTAX")  = INDTAX.L ;
1491     SCALRES1("ENTTAX")  = ENTTAX.L ;
1492     SCALRES1("TOTHHTAX") = TOTHHTAX.L ;
1493     SCALRES1("NETSUB")  = NETSUB.L ;
1494
1495     SCALRES1("REMIT")   = REMIT.L ;
1496     SCALRES1("GENT")    = GENT.L ;
1497     SCALRES1("HHT")     = HHT.L ;
1498     SCALRES1("FBOR")    = FBOR.L ;
1499
1500     SCALRES1("SAVINGS") = SAVINGS.L ;
1501     SCALRES1("ENTSAV")  = ENTSAV.L ;
1502     SCALRES1("DEPRECIA") = DEPRECIA.L ;
1503     SCALRES1("HHSAV")   = HHSAV.L ;
1504     SCALRES1("GOVSAV")  = GOVSAV.L ;
1505     SCALRES1("FSAV")    = FSAV.L ;
1506
1507     DISPLAY PRICRES1, QUANTRES1, SCALRES1 ;
1508
1509   *##################### Social Accounting Matrix #####################
1510
1511     SAM("COMMDTY","ACTIVITY")    = SUM(i,(P.L(i)*INT.L(i))) ;
1512     SAM("COMMDTY","HOUSEHOLDS")  = SUM(i,(P.L(i)*CD.L(i))) ;
1513     SAM("COMMDTY","KACCOUNT")    = SUM(i,(P.L(i)*(DST.L(i)+ID.L(i)))) ;
1514     SAM("COMMDTY","GOVT")        = SUM(i,(P.L(i)*GD.L(i))) ;
1515     SAM("ACTIVITY","WORLD")      = SUM(i,((EXR.L*PWE.L(i))*E.L(i))) ;
1516     SAM("ACTIVITY","COMMDTY")    = SUM(i,  (PX.L(i)*XD.L(i))
1517                                            - (PE.L(i)*E.L(i)) ) ;
```

```
1518    SAM("ACTIVITY","GOVT")          = NETSUB.L ;
1519    SAM("VALUAD","ACTIVITY")        = SUM(f, YFCTR.L(f)) ;
1520    SAM("INSTTNS","VALUAD")         = SUM(f,YFCTR.L(f)) - SSTAX.L ;
1521    SAM("INSTTNS","GOVT")           = GENT.L ;
1522    SAM("HOUSEHOLDS","INSTTNS")= SUM((ins,hh),SINTYH(hh,ins)*YINST.L(ins));
1523    SAM("HOUSEHOLDS","GOVT")        = HHT.L ;
1524    SAM("KACCOUNT","INSTTNS")       = ENTSAV.L + DEPRECIA.L ;
1525    SAM("KACCOUNT","HOUSEHOLDS") = HHSAV.L ;
1526    SAM("KACCOUNT","GOVT")          = GOVSAV.L ;
1527    SAM("GOVT","commdty")           = TARIFF.L ;
1528    SAM("GOVT","ACTIVITY")          = INDTAX.L ;
1529    SAM("GOVT","VALUAD")            = SSTAX.L ;
1530    SAM("GOVT","INSTTNS")           = ENTTAX.L ;
1531    SAM("GOVT","HOUSEHOLDS")        = TOTHHTAX.L ;
1532    SAM("WORLD","COMMDTY")          = SUM(i,((PWM(i)*EXR.L)*M.L(i))) ;
1533    SAM("WORLD","HOUSEHOLDS")       = - REMIT.L*EXR.L ;
1534    SAM("WORLD","GOVT")             = - FBOR.L*EXR.L ;
1535    SAM("WORLD","KACCOUNT")         = - FSAV.L*EXR.L ;
1536    SAM("TOTAL","COMMDTY")          = SUM(isam2,SAM(isam2,"COMMDTY")) ;
1537    SAM("TOTAL","ACTIVITY")         = SUM(isam2,SAM(isam2,"ACTIVITY")) ;
1538    SAM("TOTAL","VALUAD")           = SUM(isam2,SAM(isam2,"VALUAD")) ;
1539    SAM("TOTAL","INSTTNS")          = SUM(isam2,SAM(isam2,"INSTTNS")) ;
1540    SAM("TOTAL","HOUSEHOLDS")       = SUM(isam2,SAM(isam2,"HOUSEHOLDS")) ;
1541    SAM("TOTAL","KACCOUNT")         = SUM(isam2,SAM(isam2,"KACCOUNT")) ;
1542    SAM("TOTAL","GOVT")             = SUM(isam2,SAM(isam2,"GOVT")) ;
1543    SAM("total","WORLD")            = SUM(isam2,SAM(isam2,"WORLD")) ;
1544    SAM(isam3,"TOTAL")              = SUM(isam2,SAM(isam3,isam2)) ;
1545
1546    option decimals=3 ;
1547    DISPLAY SAM;
1548
1549    *########################### THE END ###########################
```

COMPILATION TIME   =   10.050 SECONDS   VER: 386-EK-008

---- 556 PARAMETER WFDIST   FACTOR PRICE SECTORAL PROPORTIONALITY CONSTANTS

	LABOR	CAPITAL	LAND
LVSTK	0.585	0.401	
EXPCRP	0.432	0.852	0.896
OTHCRP	0.501	0.899	1.415
AGPROC	0.929	2.313	
AGINP	1.156	1.111	
INTMNF	1.384	1.285	
FDMNF	1.346	1.087	
TRDTRN	0.898	1.325	
SERVICE	0.956	0.814	
RESTA	0.563	1.464	

---- 556 PARAMETER WF0   FACTOR PRICE

LABOR 19.733,   CAPITAL 0.157,   LAND   0.053

---- 556 PARAMETER FS0   FACTOR SUPPLY

LABOR   96.641,   CAPITAL 6244.072,   LAND   428.250

---- 556 PARAMETER YFSECT0   FACTOR INCOME BY SECTOR

LVSTK	9.807,	EXPCRP	29.389,	OTHCRP	15.199,	AGPROC	98.626
AGINP	34.223,	INTMNF	269.408,	FDMNF	312.655,	TRDTRN	437.355
SERVICE	1542.043,	RESTA	158.519				

---- 556 PARAMETER YFCTR0   FACTOR INCOME SUMMED OVER SECTOR

LABOR 1907.000,   CAPITAL 977.319,   LAND   22.905

---- 557 PARAMETER YINST0   INSTITUTIONAL INCOME

LABR 1637.465,   ENT   558.575,   PROP   22.905

---- 557 PARAMETER YH0   HOUSEHOLD INCOME

HHTRN 396.250,   HHLAB 1637.465,   HHCAP 580.231

---- 557 PARAMETER MPS0   HOUSEHOLD MARGINAL PROPENSITY TO SAVE

HHLAB 0.062,   HHCAP 0.174

---- 557 PARAMETER HTAX   HOUSEHOLD TAX RATE

HHLAB 0.126,   HHCAP 0.350

---- 557 PARAMETER ETR   =   0.098 ENTERPRISE TAX RATE
     PARAMETER ESR   =   0.035 ENTERPRISE SAVINGS RATE
     PARAMETER SSTR   =   0.141 SOCIAL SECURITY TAX RATE

---- 571 PARAMETER DELTA   ARMINGTON FUNCTION SHARE PARAMETER

LVSTK	0.233,	EXPCRP	0.177,	OTHCRP	0.366
AGPROC	0.211,	AGINP	0.042,	INTMNF	0.067
FDMNF	0.152,	TRDTRN	0.004,	SERVICE 2.580477E-9	

---- 571 PARAMETER AC   ARMINGTON FUNCTION SHIFT PARAMETER

| LVSTK | 1.420, | EXPCRP | 1.297, | OTHCRP | 1.773, | AGPROC | 1.498, | AGINP | 1.269 |
| INTMNF | 1.365, | FDMNF | 1.563, | TRDTRN | 1.022, | SERVICE | 1.024, | RESTA | 1.000 |

---- 571 PARAMETER RMD   RATIO OF IMPORTS TO DOMESTIC SALES

| LVSTK | 0.008, | EXPCRP | 0.002, | OTHCRP | 0.111, | AGPROC | 0.071, | AGINP | 0.096 |
| INTMNF | 0.138, | FDMNF | 0.213, | TRDTRN | 0.002, | SERVICE | 0.019 | | |

---- 579 PARAMETER GAMMA   CET FUNCTION SHARE PARAMETER

| LVSTK | 1.000, | EXPCRP | 0.568, | OTHCRP | 0.802, | AGPROC | 0.819, | AGINP | 0.781 |
| INTMNF | 0.788, | FDMNF | 0.778, | TRDTRN | 0.818, | SERVICE | 0.995, | RESTA | 0.998 |

---- 579 PARAMETER AT   CET FUNCTION SHIFT PARAMETER

LVSTK	51.023,	EXPCRP	2.074,	OTHCRP	3.006,	AGPROC	3.175
AGINP	2.823,	INTMNF	2.876,	FDMNF	2.612,	TRDTRN	3.162
SERVICE	7.365,	RESTA	10.406				

---- 584 PARAMETER ALPHA   FACTOR SHARE PARAMETER-PRODUCTION FUNCTION

	LABOR	CAPITAL	LAND
LVSTK	0.489	0.511	
EXPCRP	0.113	0.328	0.559
OTHCRP	0.323	0.251	0.427
AGPROC	0.667	0.333	
AGINP	0.592	0.408	
INTMNF	0.571	0.429	
FDMNF	0.841	0.159	
TRDTRN	0.755	0.245	
SERVICE	0.680	0.320	
RESTA	0.075	0.925	

---- 591 PARAMETER AD   PRODUCTION FUNCTION SHIFT PARAMETER

LVSTK	12.617,	EXPCRP	0.751,	OTHCRP	2.182,	AGPROC	37.138
AGINP	47.468,	INTMNF	16.892,	FDMNF	48.285,	TRDTRN	18.680
SERVICE	12.075,	RESTA	0.583				

---- 591 PARAMETER QD   DUMMY VARIABLE FOR COMPUTING AD(I)

LVSTK	6.112,	EXPCRP	95.520,	OTHCRP	12.165,	AGPROC	10.532
AGINP	5.589,	INTMNF	40.951,	FDMNF	16.933,	TRDTRN	42.026
SERVICE	216.065,	RESTA	395.827				

---- 591 PARAMETER FDO   FACTOR DEMAND

LABOR   96.641,   CAPITAL 6244.073,   LAND   428.251

---- 597 PARAMETER XDO   DOMESTIC OUTPUT

LVSTK	77.115,	EXPCRP	71.773,	OTHCRP	26.544,	AGPROC	391.145
AGINP	265.280,	INTMNF	691.753,	FDMNF	817.594,	TRDTRN	785.067
SERVICE	2609.047,	RESTA	230.939				

```
----  597 PARAMETER X0          COMPOSITE GOOD SUPPLY

LVSTK      77.557,   EXPCRP   53.983,   OTHCRP   27.809,   AGPROC   399.482
AGINP     269.608,   INTMNF  734.080,   FDMNF   861.036,   TRDTRN   749.789
SERVICE  2549.723,   RESTA   225.490


----  597 PARAMETER XXD0         DOMESTIC SALES

LVSTK      76.904,   EXPCRP   53.866,   OTHCRP   25.026,   AGPROC   372.919
AGINP     245.939,   INTMNF  644.884,   FDMNF   709.591,   TRDTRN   747.944
SERVICE  2501.795,   RESTA   225.490


----  598 PARAMETER PVA0         VALUE ADDED PRICE BY SECTOR

LVSTK   0.127,   EXPCRP  0.409,   OTHCRP  0.573,   AGPROC  0.252,   AGINP  0.129
INTMNF  0.389,   FDMNF   0.382,   TRDTRN  0.557,   SERVICE 0.591,   RESTA  0.686


----  598 PARAMETER PD0          DOMESTIC GOODS PRICE

LVSTK   1.000,   EXPCRP  1.000,   OTHCRP  1.000,   AGPROC  1.000,   AGINP  1.000
INTMNF  1.000,   FDMNF   1.000,   TRDTRN  1.000,   SERVICE 1.000,   RESTA  1.000


----  598 PARAMETER PE0          DOMESTIC PRICE OF EXPORTS

LVSTK   1.000,   EXPCRP  1.000,   OTHCRP  1.000,   AGPROC  1.000,   AGINP  1.000
INTMNF  1.000,   FDMNF   1.000,   TRDTRN  1.000,   SERVICE 1.000,   RESTA  1.000


----  598 PARAMETER PWE0         WORLD PRICE OF EXPORTS

LVSTK   1.000,   EXPCRP  1.000,   OTHCRP  1.000,   AGPROC  1.000,   AGINP  1.000
INTMNF  1.000,   FDMNF   1.000,   TRDTRN  1.000,   SERVICE 1.000,   RESTA  1.000


----  598 PARAMETER PM0          DOMESTIC PRICE OF IMPORTS

LVSTK   1.000,   EXPCRP  1.000,   OTHCRP  1.000,   AGPROC  1.000,   AGINP  1.000
INTMNF  1.000,   FDMNF   1.000,   TRDTRN  1.000,   SERVICE 1.000,   RESTA  1.000


----  598 PARAMETER PWM          WORLD MARKET PRICE OF IMPORTS (IN DOLLARS)

LVSTK   0.987,   EXPCRP  0.972,   OTHCRP  0.964,   AGPROC  0.897,   AGINP  0.997
INTMNF  0.982,   FDMNF   0.973,   TRDTRN  0.973,   SERVICE 1.000,   RESTA  1.000


----  598 PARAMETER TM           TARIFF RATES ON IMPORTS

LVSTK      0.014,   EXPCRP   0.029,   OTHCRP        0.037
AGPROC     0.115,   AGINP    0.003,   INTMNF        0.018
FDMNF      0.027,   TRDTRN   0.027,   SERVICE 8.345875E-6


----  598 PARAMETER PWTS         PRICE INDEX WEIGHTS

LVSTK   0.013,   EXPCRP  0.012,   OTHCRP  0.004,   AGPROC  0.066,   AGINP  0.044
INTMNF  0.116,   FDMNF   0.137,   TRDTRN  0.132,   SERVICE 0.437,   RESTA  0.039


----  744 VARIABLE  YFCTR.L      FACTOR INCOME
                                 (BILL $)

LABOR  1907.000,   CAPITAL 977.319,   LAND   22.905


----  744 VARIABLE  YINST.L      INSTITUTIONAL INCOME
                                 (BILL $)
```

LABR 1637.465,   ENT   558.575,   PROP   22.905

----   744 VARIABLE   YH.L   HOUSEHOLD INCOME
                                       (BILL $)

HHTRN 396.250,   HHLAB 1637.465,   HHCAP 580.231

----   744 VARIABLE   GNPVA.L   =   3166.001 VALUE ADDED IN MARKET
                                                       PRICES GNP
                                                       (BILL $)
        VARIABLE   RGNP.L   =   3166.002 REAL GNP
                                                              (82 BILL
                                                       $)
        VARIABLE   PINDEX.L   =   1.000 GNP DEFLATOR

----   745 VARIABLE   INT.L   INTERMEDIATES USES   (82
                                       BILL $)

LVSTK   70.466,   EXPCRP   46.071,   OTHCRP   15.768,   AGPROC 160.111
AGINP   195.025,   INTMNF 694.450,   FDMNF   389.942,   TRDTRN 337.164
SERVICE 767.737,   RESTA   132.121

----   745 VARIABLE   CD.L   FINAL DEMAND FOR PRIVATE CONSUMPTION   (82
                                       BILL $)

LVSTK   6.597,   EXPCRP   0.914,   OTHCRP   11.488,   AGPROC 231.451
AGINP   55.811,   INTMNF   22.496,   FDMNF   216.391,   TRDTRN 386.724
SERVICE 1041.077,   RESTA   77.752

----   745 VARIABLE   GD.L   FINAL DEMAND FOR GOVERNMENT CONSUMPTION (82
                                       BILL $)

LVSTK   0.431,   EXPCRP   7.475,   OTHCRP   0.681,   AGPROC   9.138
AGINP   12.500,   INTMNF   12.749,   FDMNF   97.993,   TRDTRN   28.760
SERVICE 465.610,   RESTA   6.364

----   745 VARIABLE   ID.L   FINAL DEMAND FOR PRODUCTIVE INVESTMENT (82
                                       BILL $)

AGPROC   1.180,   AGINP   8.418,   INTMNF   8.724,   FDMNF   165.525
SERVICE 278.703,   RESTA   9.252

----   745 VARIABLE   DST.L   INVENTORY INVESTMENT BY SECTOR   (82
                                       BILL $)

LVSTK   0.063,   EXPCRP   -0.477,   OTHCRP   -0.129,   AGPROC   -2.399
AGINP   -2.146,   INTMNF   -4.339,   FDMNF   -8.814,   TRDTRN   -2.858
SERVICE -3.402

----   745 VARIABLE   DK.L   VOLUME OF INVESTMENT BY SECTOR OF DESTINATION
                                       (82 BILL $)

LVSTK   6.033,   EXPCRP   5.462,   OTHCRP   2.045,   AGPROC   6.863
AGINP   6.074,   INTMNF   43.421,   FDMNF   22.009, · TRDTRN   38.997
SERVICE 292.551,   RESTA   48.345

---- 789 PARAMETER SAM   SOCIAL ACCOUNTING MATRIX

	COMMDTY	ACTIVITY	VALUAD	INSTTNS	HOUSEHOLDS	GOVT
COMMDTY		2808.86			2050.70	641.70
ACTIVITY	5604.36					
VALUAD		2907.22				
INSTTNS			2637.69			47.53
HOUSEHOLDS				2218.95		396.25
GOVT	8.60	250.18	269.54	63.08	409.34	
KACCOUNT				403.19	153.91	-110.83
WORLD	335.60				1.25	26.08
TOTAL	5948.56	5966.26	2907.22	2685.22	2615.20	1000.73

+	KACCOUNT	WORLD	TOTAL
COMMDTY	447.30		5948.56
ACTIVITY		361.90	5966.26
VALUAD			2907.22
INSTTNS			2685.22
HOUSEHOLDS			2615.20
GOVT			1000.73
KACCOUNT			446.27
WORLD	-1.03		361.90
TOTAL	446.27	361.90	

MODEL STATISTICS

BLOCKS OF EQUATIONS	45	SINGLE EQUATIONS	232	
BLOCKS OF VARIABLES	50	SINGLE VARIABLES	260	
NON ZERO ELEMENTS	1321	NON LINEAR N-Z	624	
DERIVATIVE POOL	23	CONSTANT POOL	233	
CODE LENGTH	7354			

GENERATION TIME   =   14.550 SECONDS

EXECUTION TIME   =   23.460 SECONDS   VER: 386-EK-008

                 S O L V E   S U M M A R Y

        MODEL   US82   OBJECTIVE RGNP
        TYPE   NLP   DIRECTION MAXIMIZE
        SOLVER   MINOS5   FROM LINE 1048

**** SOLVER STATUS   1 NORMAL COMPLETION
**** MODEL STATUS   2 LOCALLY OPTIMAL
**** OBJECTIVE VALUE   3166.0009

   RESOURCE USAGE, LIMIT   39.000   1000.000
   ITERATION COUNT, LIMIT   195   1000
   EVALUATION ERRORS   0   0

      M I N O S   5.2   (Jun 1989)
      = = = = =

   B. A. Murtagh, University of New South Wales
      and
   P. E. Gill, W. Murray, M. A. Saunders and M. H. Wright
   Systems Optimization Laboratory, Stanford University.

WORK SPACE NEEDED (ESTIMATE) --   21910 WORDS.
WORK SPACE ALLOCATED   --   39052 WORDS.

EXIT -- OPTIMAL SOLUTION FOUND
MAJOR ITNS, LIMIT   8   50
FUNOBJ, FUNCON CALLS   0   13
SUPERBASICS   0
INTERPRETER USAGE   0.00
NORM RG / NORM PI   0.000E+00

**** REPORT SUMMARY :   0   NONOPT
                             0 INFEASIBLE
                             0 UNBOUNDED
                             0   ERRORS

---- 1138 PARAMETER SCALRES

EXR	1.000000,	PINDEX	1.000000,	GDTOT	641.700000
INVEST	447.299106,	SSTAX	269.535307,	ENTTAX	63.079604
TOTHHTAX	409.335718,	REMIT	-1.250000,	GENT	47.530000
HHT	396.249995,	FBOR	-26.080000,	ENTSAV	20.030312
HHSAV	153.907905,	GOVSAV	-110.833019,	FSAV	1.029951
RGNP	3166.000916,	GNPVA	3166.000217,	FXDINV	471.800138
GR	974.646839,	TARIFF	8.599994,	INDTAX	250.176203
SAVINGS	447.299106,	DEPRECIA	383.163957		

---- 1138 PARAMETER FCTRES1   FACTOR DEMAND BY SECTOR

	LABOR	CAPITAL	LAND
LVSTK	0.415351	79.843460	
EXPCRP	0.389789	72.291068	342.600644
OTHCRP	0.495859	27.070361	85.649356
AGPROC	3.584818	90.829040	
AGINP	0.887447	80.391815	
INTMNF	5.635198	574.657979	
FDMNF	9.907518	291.267435	
TRDTRN	18.648109	516.105260	
SERVICE	55.605910	3871.779401	
RESTA	1.071000	639.836181	

---- 1138 PARAMETER FCTRES2   MISCELLANEOUS FACTOR VARIABLE RESULTS

	LABOR	CAPITAL	LAND
WF	19.732823	0.156519	0.053486
FS	96.640999	6244.071998	428.250000
YFCTR	1906.999485	977.319011	22.905524

---- 1138 PARAMETER SECTRES   SECTORAL QUANTITIES AND PRICES

	LVSTK	EXPCRP	OTHCRP	AGPROC	AGINP	INTMNF
XD	77.114749	71.773227	26.543486	391.146007	265.279442	691.750952
E	0.211589	17.906952	1.517499	18.226625	19.340700	46.868797
M	0.653642	0.116665	2.782435	26.562726	23.669220	89.196029
PX	0.999999	1.000000	1.000002	1.000000	1.000000	1.000000
PE	1.000002	0.999999	1.000001	1.000000	1.000000	1.000000
PM	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
P	0.999999	1.000000	1.000002	1.000000	1.000000	1.000000
PD	0.999999	1.000000	1.000002	1.000000	1.000000	1.000000
PK	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
PVA	0.127177	0.409476	0.572615	0.252146	0.129008	0.389458
PWE	1.000002	1.000000	1.000002	1.000000	1.000000	1.000000
X	77.556803	53.982940	27.808421	399.482108	269.607962	734.078184
XXD	76.903161	53.866275	25.025986	372.919382	245.938742	644.882155
INT	70.466404	46.070617	15.767772	160.111561	195.024743	694.448788
CD	6.597278	0.914244	11.488463	231.451029	55.811001	22.495797
GD	0.430580	7.475156	0.680843	9.137799	12.499662	12.748641
ID				1.180227	8.418136	8.723619
DST	0.062540	-0.477077	-0.128656	-2.398507	-2.145580	-4.338662
DK	6.032910	5.462031	2.045254	6.863278	6.074428	43.421192

+	FDMNF	TRDTRN	SERVICE	RESTA
XD	817.592523	785.067874	2609.047697	230.939457

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E    108.002865    37.123250   107.252247      5.449356
M    151.445547     1.845286    47.928278
PX     1.000000     1.000000     1.000000      1.000000
PE     1.000000     1.000000     1.000000      1.000000
PM     1.000000     1.000000     1.000000      1.000000
P      1.000000     1.000000     1.000000      1.000000
PD     1.000000     1.000000     1.000000      1.000000
PK     1.000000     1.000000     1.000000      1.000000
PVA    0.382409     0.557092     0.591037      0.686410
PWE    1.000000     1.000000     1.000000      1.000000
X    861.035204   749.789910  2549.723727    225.490101
XXD  709.589658   747.944624  2501.795450    225.490101
INT  389.942009   337.163928   767.737187    132.121488
CD   216.390846   386.724090  1041.076569     77.752339
GD    97.992626    28.760324   465.609996      6.364374
ID   165.524188                278.702174      9.251900
DST   -8.814465    -2.858432    -3.402198
DK    22.008538    38.997121   292.550121     48.345371
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----    1138 PARAMETER INSRES          INSTITUTIONAL INCOME RESULTS

              LABR          ENT          PROP

YINST 1637.464178    558.575138     22.905524
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----    1138 PARAMETER HHRES           MISCELLANEOUS HOUSEHOLD RESULTS

            HHTRN         HHLAB         HHCAP

MPS                     0.061607      0.174295
YH   396.249995    1637.464178    580.230662
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```
----    1251 PARAMETER AGTOTFD        =      100.000 AGRICULTURAL TERMS OF TRADE
             PARAMETER AGTOTVA        =       62.939 AG TERMS OF TRADE VALUE
                                                     ADDED
             PARAMETER AGTOTM         =       99.345 AG TERMS OF TRADE WORLD
                                                     IMPORT PRICE
             PARAMETER AGTOTE         =      100.000 AG TERMS OF TRADE WORLD
                                                     EXPORT PRICE
----    1275 PARAMETER BOT            =       26.300 NOMINAL BALANCE OF TRADE
             PARAMETER BOTR           =       17.700 REAL BALANCE OF TRADE
             PARAMETER NEX            =      361.900 NOMINAL EXPORTS
             PARAMETER ESUM           =      361.900 REAL EXPORTS
             PARAMETER NIM            =      335.600 NOMINAL IMPORTS
             PARAMETER MSUM           =      344.200 REAL IMPORTS
             PARAMETER SHCONSUMP      =       64.773 CONSUMPTION SHARE OF
                                                     NOMINAL GNP
             PARAMETER SHINVEST       =       14.128 INVESTMENT SHARE OF
                                                     NOMINAL GNP
             PARAMETER SHGDTOT        =       20.268 GOVT CONSUMPTION SHARE OF
                                                     NOMINAL GNP
             PARAMETER SHEX           =       11.431 EXPORT SHARE OF NOMINAL GNP
             PARAMETER SHIM           =       10.600 IMPORT SHARE OF NOMINAL GNP
             PARAMETER SHBOT          =        0.831 BALANCE OF TRADE SHARE OF
                                                     NOMINAL GNP
             PARAMETER SHFSAV         =        0.230 FOREIGN SAVING SHARE OF
                                                     INVESTMENT
             PARAMETER SHGSAV         =      -24.778 GOVERNMENT SAVING SHARE OF
                                                     INVESTMENT
             PARAMETER SHPSAV         =      124.548 PRIVATE SAVING SHARE OF
                                                     INVESTMENT
----    1297 PARAMETER COLIND         =      100.000 COST OF LIVING INDEX
             PARAMETER EXRIND         =      100.000 REAL EXCHANGE RATE INDEX
             PARAMETER NGNP           =     3166.000 NOMINAL GNP
             PARAMETER PDIND          =      100.000 DOMESTIC SUPPLY PRICE INDEX
             PARAMETER PIND           =      100.000 COMPOSITE GOOD PRICE INDEX
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PARAMETER PEIND          =    100.000 DOMESTIC EXPORT PRICE INDEX
PARAMETER PMIND          =    100.000 DOMESTIC IMPORT PRICE INDEX
PARAMETER PWEIND         =    100.000 WORLD EXPORT PRICE INDEX
PARAMETER PWMIND         =     97.501 WORLD IMPORT PRICE INDEX
PARAMETER PXIND          =    100.000 PRODUCER PRICE INDEX
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---- 1349 PARAMETER GNPTAB   GNP ACCOUNTS

	NOMINAL	REAL	NOMSHARE	REALSHARE	DEFLATOR
CONSMPT	2050.701	2050.702	64.773	64.773	100.000
INVESTMENT	471.800	471.800	14.902	14.902	100.000
INVENTORY	-24.501	-24.501	-0.774	-0.774	100.000
GOVERNMENT	641.700	641.700	20.268	20.268	100.000
EXPORTS	361.900	361.900	11.431	11.431	100.000
IMPORTS	-335.600	-335.600	-10.600	-10.600	100.000
GNP	3166.000	3166.001	100.000	100.000	100.000

---- 1349 PARAMETER GNPTAB2   SECTORAL VALUE ADDED

	NOMINAL	REAL	NOMSHARE	REALSHARE	DEFLATOR
LVSTK	11.176	11.176	0.353	0.353	99.999
EXPCRP	30.666	30.666	0.969	0.969	100.000
OTHCRP	15.585	15.585	0.492	0.492	100.000
AGPROC	109.400	109.400	3.455	3.455	100.000
AGINP	40.316	40.316	1.273	1.273	100.000
INTMNF	296.374	296.374	9.361	9.361	100.000
FDMNF	322.350	322.351	10.182	10.182	100.000
TRDTRN	513.082	513.082	16.206	16.206	100.000
SERVICE	1638.117	1638.117	51.741	51.741	100.000
RESTA	188.934	188.934	5.968	5.968	100.000

---- 1349 PARAMETER SUMGNP   AGGREGATE GNP

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NOMINAL  3166.000,   REAL    3166.001,   NOMSHARE   100.000
REALSHARE  100.000
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---- 1349 PARAMETER GNPRATIO   =   1.000 GNP VALUE ADDED CORRECTION
                                                     FACTOR

---- 1379 PARAMETER ABSORB   ABSORPTION TABLE (REAL)

	E	M	GNP	C	I	G
TOTAL	361.900	344.200	3166.001	2050.702	471.800	641.700
AG	19.636	3.553	43.127	19.000		8.587
NON-AG	342.264	340.647	3122.874	2031.702	471.800	633.113

	NETE-M	T-G	ABSORB
TOTAL	17.700	-110.833	3164.202
AG	16.083		27.587
NON-AG	1.617		3136.615

---- 1398 PARAMETER AVGWF   AVERAGE FACTOR PRICE CURRENT WEIGHTS

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LABOR  19.733,   CAPITAL  0.157,   LAND   0.053
```

---- 1398 PARAMETER AVGPROFIT   =   0.157 AVERAGE PROFIT RATE

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----    1398 PARAMETER VALADD          VALUE ADDED AT MARKET PRICE

LVSTK      11.176,    EXPCRP    30.666,    OTHCRP     15.585,    AGPROC    109.400
AGINP      40.316,    INTMNF   296.374,    FDMNF     322.350,    TRDTRN    513.082
SERVICE  1629.517,    RESTA    188.934


----    1398 PARAMETER SECTORY         VALUE ADDED AT FACTOR COST

LVSTK       9.807,    EXPCRP    29.389,    OTHCRP     15.199,    AGPROC     98.626
AGINP      34.223,    INTMNF   269.408,    FDMNF     312.654,    TRDTRN    437.355
SERVICE  1542.043,    RESTA    158.519
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----    1421 PARAMETER FACTORS         FACTOR RETURNS DISTRIBUTIVE PARAMETERS
```

	YF	YFCAP	PROFIT	RENTAL	RDIST	WDCAP
LVSTK	9.807	5.015	0.063	0.063	0.401	0.401
EXPCRP	29.389	9.644	0.133	0.133	0.852	0.852
OTHCRP	15.199	3.808	0.141	0.141	0.899	0.899
AGPROC	98.626	32.884	0.362	0.362	2.313	2.313
AGINP	34.223	13.975	0.174	0.174	1.111	1.111
INTMNF	269.408	115.536	0.201	0.201	1.285	1.285
FDMNF	312.654	49.561	0.170	0.170	1.087	1.087
TRDTRN	437.355	107.022	0.207	0.207	1.325	1.325
SERVICE	1542.043	493.262	0.127	0.127	0.814	0.814
RESTA	158.519	146.611	0.229	0.229	1.464	1.464

+	YFLABOR	WDLABOR	YFLAND	WDLAND	PINT	INTINP
LVSTK	4.793	0.585			0.855	65.939
EXPCRP	3.324	0.432	16.421	0.896	0.573	41.108
OTHCRP	4.907	0.501	6.484	1.415	0.413	10.958
AGPROC	65.741	0.929			0.720	281.746
AGINP	20.248	1.156			0.848	224.964
INTMNF	153.872	1.384			0.572	395.377
FDMNF	263.093	1.346			0.606	495.242
TRDTRN	330.333	0.898			0.346	271.986
SERVICE	1048.781	0.956			0.375	979.530
RESTA	11.908	0.563			0.182	42.005

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----    1421 PARAMETER COEFFS          SHIFT
```

	ALPHAL	ALPHAC	ALPHAP	RMD	DELTA	AD
LVSTK	0.489	0.511		0.008	0.233	12.617
EXPCRP	0.113	0.328	0.559	0.002	0.177	0.751
OTHCRP	0.323	0.251	0.427	0.111	0.366	2.182
AGPROC	0.667	0.333		0.071	0.211	37.138
AGINP	0.592	0.408		0.096	0.042	47.468
INTMNF	0.571	0.429		0.138	0.067	16.892
FDMNF	0.841	0.159		0.213	0.152	48.285
TRDTRN	0.755	0.245		0.002	0.004	18.680
SERVICE	0.680	0.320		0.019	2.580477E-9	12.075
RESTA	0.075	0.925				0.583

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----    1507 PARAMETER PRICRES1        PRICE RESULTS BY SECTOR
```

	PX	PE	PM	P	PD	PVA
LVSTK	1.000	1.000	1.000	1.000	1.000	0.127
EXPCRP	1.000	1.000	1.000	1.000	1.000	0.409
OTHCRP	1.000	1.000	1.000	1.000	1.000	0.573
AGPROC	1.000	1.000	1.000	1.000	1.000	0.252
AGINP	1.000	1.000	1.000	1.000	1.000	0.129
INTMNF	1.000	1.000	1.000	1.000	1.000	0.389

FDMNF	1.000	1.000	1.000	1.000	1.000	0.382
TRDTRN	1.000	1.000	1.000	1.000	1.000	0.557
SERVICE	1.000	1.000	1.000	1.000	1.000	0.591
RESTA	1.000	1.000	1.000	1.000	1.000	0.686

+	PWE	PROFIT	RENTAL	PINT	PWM
LVSTK	1.000	0.063	0.063	0.855	0.987
EXPCRP	1.000	0.133	0.133	0.573	0.972
OTHCRP	1.000	0.141	0.141	0.413	0.964
AGPROC	1.000	0.362	0.362	0.720	0.897
AGINP	1.000	0.174	0.174	0.848	0.997
INTMNF	1.000	0.201	0.201	0.572	0.982
FDMNF	1.000	0.170	0.170	0.606	0.973
TRDTRN	1.000	0.207	0.207	0.346	0.973
SERVICE	1.000	0.127	0.127	0.375	1.000
RESTA	1.000	0.229	0.229	0.182	1.000

---- 1507 PARAMETER QUANTRES1   QUANTITY RESULTS BY SECTOR

	LABOR	CAPITAL	LAND	XD	E	M
LVSTK	0.415	79.843		77.115	0.212	0.654
EXPCRP	0.390	72.291	342.601	71.773	17.907	0.117
OTHCRP	0.496	27.070	85.649	26.543	1.517	2.782
AGPROC	3.585	90.829		391.146	18.227	26.563
AGINP	0.887	80.392		265.279	19.341	23.669
INTMNF	5.635	574.658		691.751	46.869	89.196
FDMNF	9.908	291.267		817.593	108.003	151.446
TRDTRN	18.648	516.105		785.068	37.123	1.845
SERVICE	55.606	3871.779		2609.048	107.252	47.928
RESTA	1.071	639.836		230.939	5.449	

+	X	XXD	VALADD	SECTORY
LVSTK	77.557	76.903	11.176	9.807
EXPCRP	53.983	53.866	30.666	29.389
OTHCRP	27.808	25.026	15.585	15.199
AGPROC	399.482	372.919	109.400	98.626
AGINP	269.608	245.939	40.316	34.223
INTMNF	734.078	644.882	296.374	269.408
FDMNF	861.035	709.590	322.350	312.654
TRDTRN	749.790	747.945	513.082	437.355
SERVICE	2549.724	2501.795	1629.517	1542.043
RESTA	225.490	225.490	188.934	158.519

---- 1507 PARAMETER SCALRES1   AGGREGATE VARIABLES

EXR	1.000,	PINDEX	1.000,	GDTOT	641.700,	INVEST	447.299
SSTAX	269.535,	ENTTAX	63.080,	TOTHHTAX	409.336,	REMIT	-1.250
GENT	47.530,	HHT	396.250,	FBOR	-26.080,	ENTSAV	20.030
HHSAV	153.908,	GOVSAV	-110.833,	FSAV	1.030,	RGNP	3166.001
GNPVA	3166.000,	FXDINV	471.800,	GR	974.647,	TARIFF	8.600
INDTAX	250.176,	SAVINGS	447.299,	DEPRECIA	383.164		

---- 1547 PARAMETER SAM   SOCIAL ACCOUNTING MATRIX

	COMMDTY	ACTIVITY	VALUAD	INSTTNS	HOUSEHOLDS	GOVT
COMMDTY		2808.854			2050.701	641.700
ACTIVITY	5604.354					
VALUAD		2907.224				
INSTTNS			2637.689			47.530
HOUSEHOLDS				2218.945		396.250
GOVT	8.600	250.176	269.535	63.080	409.336	
KACCOUNT				403.194	153.908	-110.833
WORLD	335.600				1.250	26.080
TOTAL	5948.554	5966.254	2907.224	2685.219	2615.195	1000.727

+	KACCOUNT	WORLD	TOTAL
COMMDTY	447.299		5948.554
ACTIVITY		361.900	5966.254
VALUAD			2907.224
INSTTNS			2685.219
HOUSEHOLDS			2615.195
GOVT			1000.727
KACCOUNT			446.269
WORLD	-1.030		361.900
TOTAL	446.269	361.900	

**** FILE SUMMARY

INPUT   G:\US82.GMS
OUTPUT G:\US82.LST

EXECUTION TIME   =   12.140 SECONDS   VER: 386-EK-008