PN-ABC-601
6120

AGENCY FOR INTERNATIONAL DEVELOPMENT
PPC/CDIE/DI REPORT PROCESSING FORM

ENTER INFORMATION ONLY IF NOT INCLUDED ON COVER OR TITLE PAGE OF DOCUMENT

1. Project/Subproject Number: APAP/936-4084

2. Contract/Grant Number: DAN-4084-C-00-3087-00

3. Publication Date: August 1988

4. Document Title/Translated Title: APAP Microcomputer Tool No. 3: GESS, A Multiple Commodity Supply and Demand Model: Analysis of Taxation and Subsidy Policies.

5. Author(s)
1. James Trapp
2.
3.

6. Contributing Organization(s)
Abt Associates, In., Cambridge, MA
Robert R. Nathan Associates, Inc., Washington, D.C.
Abel, Daft and Earley, Inc., Alexandria, VA
~~Oklahoma State University, Dept. of Agrl. Economics, Stillwater, OK~~

7. Pagination: 36

8. Report Number:

9. Sponsoring A.I.D. Office: AID/ST/AGR/EPP

10. Abstract (optional - 250 word limit)

This generalized Econometric Spreadsheet Simulation (GESS) model analyzes alternative subsidization and taxation scenaros in a multiple commodity setting. The model estimates the impact of external (scenario determined) changes in the prices of one or more commodities included in the model on the quantities supplied and demanded of all the commodities.

11. Subject Keywords (optional)
1. microcomputer tool
2. spreadsheet
3. supply and demand model
4. taxation policies
5. subsidy policies
6. econometrics

12. Supplementary Notes

13. Submitting Official: William R. Goodwin

14. Telephone Number: (703) 875-4015

15. Today's Date:

DO NOT write below this line

16. DOCID:

17. Document Disposition: DOCRD [ ] INV [ ] DUPLICATE [ ]

WORK SHEET

AGENCY FOR INTERNATIONAL DEVELOPMENT
PPC/CDIE/DI REPORT PROCESSING FORM

ENTER INFORMATION ONLY IF NOT INCLUDED ON COVER OR TITLE PAGE OF DOCUMENT

1. Project/Subproject Number: APAP/936-4084

2. Contract/Grant Number: DAN-4084-C00-3087-00

3. Publication Date:

4. Document Title/Translated Title: APAP Microcomputer Tool No.

5. Author(s)
1.
2.
3.

6. Contributing Organization(s)
Abt Associates, Inc., Cambridge, MA.
Robert E. Nathan Associates, Inc., Washington, D.C.
Abel, Daft and Earley, Inc., Alexandria, VA Oaklahoma State University Dept. of Agric. Economics, Stillwater, OK

7. Pagination:

8. Report Number:

9. Sponsoring A.I.D. Office:

2. Trapp, James N. "GESS: A Multiple Commodity Supply and Demand Model for the Analysis of Taxation and Subsidy Policies."

10. Abstract

This Generalized Econometric Spreadsheet Simulation (GESS) model was developed to operate on a Lotus 1-2-3 or comparable spreadsheet (not included in the tool kit package). The user friendly model is designed for use in analyzing alternative commodity subsidization and taxation scenarios. Given an external "scenario" determined change in one or more commodities included in the system, the model estimates changes in the quantities supplied and demanded of all the commodities. An individual with no prior computer experience can be trained to operate the model in less than one day. Policy analysis using the model is accomplished by editing well documented tables of input information. A basic knowledge of elasticities and supply and demand theory is helpful in understanding and interpreting results of simulated policy options. Editing of the policy input tables to consider new scenarios requires only a few minutes, thus the model can be used effectively in a quick response policy analysis environment.

11. Subject Keywords (optional)
1.
2.
3.
4.
5.
6.

12. Supplementary Notes

13. Submitting Official: William R. Goodwin

14. Telephone Number: (703) 875-4015

15. Today's Date:

DO NOT write below this line

16. DOCID:

17. Document Disposition: DOCRD [ ] INV [ ] DUPLICATE [ ]

AID 590-7 (10/88)

PN-ABC-601

AGRICULTURAL POLICY ANALYSIS PROJECT

Under contract to the Agency for International Development, Bureau for Science and Technology, Office of Agriculture
Project Office 4250 Connecticut Avenue, N.W., Washington, D.C. 20008 • Telephone (202) 362-2800

GESS

A MULTIPLE COMMODITY SUPPLY AND DEMAND MODEL

USER'S MANUAL

APAP Microcomputer Tool No. 3

August 1988

Prepared by

James N. Trapp
Department of Agricultural Economics
Oklahoma State University
Stillwater, OK

Prime Contractor: **Abt Associates Inc.**, 55 Wheeler Street, Cambridge, Massachusetts 02138 • (617) 492-7100
Subcontractors: **Robert R. Nathan Associates, Inc.** 1301 Pennsylvania Avenue, N.W., Washington, D.C. 20004 • (202) 393-2700
Abel, Daft & Earley, 1339 Wisconsin Avenue, N.W., Washington, D.C. 20007 • (202) 342-7620
Oklahoma State University, Department of Agricultural Economics, Stillwater, Oklahoma 74078 • (405) 624-6157

EXECUTIVE SUMMARY

Taxation and subsidization often play a major role in Agricultural Policy implementation. They are frequently used as tools to attempt to control economic activity in various components of the Agricultural Sector. For example, a common policy in many developing nations has been to subsidize the production of staple food crops such as rice, and tax export crops such as coffee, cocoa, and cotton. In order to plan taxation and subsidization policy some method must be available to estimate the impacts of various taxes and subsidies. Policy decision makers often have questions concerning the impacts of taxes and subsidies upon production and consumption levels, farm income, government costs and revenues, the balance of trade, etc. The Generalized Econometric Spreadsheet Simulation (GESS) model as presented here has been specifically designed to aid in answering such policy questions.

The GESS model has been designed to operate on a LOTUS 1-2-3 spreadsheet, or a comparable spreadsheet. Operation of the model is "user friendly." An individual with no prior computer experience can be trained to operate the model in less than a day. Operation of the model is essentially done by editing well documented tables of input information. A basic understanding of elasticities and supply and demand theory is helpful in understanding and interpreting the results of various policy scenarios tested. Editing of the policy input tables to consider new subsidization and taxation scenarios requires only a few minutes. Solution of the model requires only a

few seconds. Hence, the model has a quick response capability which is often critical in policy analysis.

The purpose of this Manual is to provide the reader with a thorough understanding of the GESS Modeling concept. The main body of the Manual provides a description of the structure of the model and a review of the economic theory the model is based upon. Appendix A then provides a detailed discussion of how to develop a prototype GESS model using LOTUS 1-2-3. Instructions, together with a three commodity case example set of data and parameters, are provided to enable the user to actually program a three commodity GESS model. A working knowledge of LOTUS 1-2-3 is required to implement and comprehend the material in Appendix A. The required level of knowledge of LOTUS 1-2-3 does not go beyond that obtainable in an introductory LOTUS 1-2-3 short course and also is obtainable through self training using the LOTUS Tutorial and/or any of a number of LOTUS 1-2-3 Training Guides.

USER'S MANUAL FOR THE DEVELOPMENT OF A GENERALIZED ECONOMETRIC SPREADSHEET SIMULATION MODEL

*by James N. Trapp**

An Overview of Simulation Analysis

Simulation analysis involves the study of a "system" where a system is broadly defined as a set of interconnected elements (components) organized toward a goal or set of goals. Analysis of a system involves defining the interconnections (structure) of the system in question and the goal(s) of the system. In identifying the goals of the system one must necessarily also consider the participants in the system, i.e. producers, consumers, and policy makers.

Simulation is defined as the process of numerically solving a computerized mathematical model in an attempt to reproduce the actual essential elements of a operating system. Operating systems of interest to economics include firms, markets, and government agencies.

Simulation attempts to reproduce on a small scale the actual essential elements of an operating market, socio-economic system, or other unit of inquiry. By allowing the analyst to observe and experiment with the working of the system in the "laboratory" of a computer model, simulation is a powerful tool of policy analysis. Because of computational requirements of simulation models, it is not coincidental that their popularity has been closely correlated with the use of computers.

---

*Professor, Department of Agricultural Economics, Oklahoma State University, Stillwater, OK 74078.

Simulation may be simple or complex. Tradeoffs are inevitable: large models provide greater realism, but are costly to build and maintain; small models are less costly, but may lack essential realism. There is merit in keeping simulation models as simple as possible consistent with meeting the needs of the policy analysis at hand.

Agricultural Sector Econometric Modeling Using Spreadsheets

A particular application of simulation that has been found to be very adaptable and useful for modeling of agricultural policy decisions is the Generalized Econometric Spreadsheet Simulation Model (GESS Model). In the past most econometric simulation models have been developed case by case. Individually unique models using FORTRAN, PL-1, or other basic computer languages were built for each modeling effort. No generalized modeling framework existed to aid in the model's computer implementation. The GESS Model provides a generalized framework for computer implementation of an econometric model of a developing country's agricultural sector.

The following section will present the general methodology of the GESS Model. First, the general structure assumed for the model will be presented. Second, the theoretical underpinnings of this structure will be discussed. Lastly the procedure developed for implementing the model in a spreadsheet format will be presented.

1. Model Structure. A large majority of small developing countries have agricultural sectors with an economic market structure similar to that depicted in Figure 1. Prices are essentially determined by two exogenous forces: the government and/or the world market. These prices in turn determine

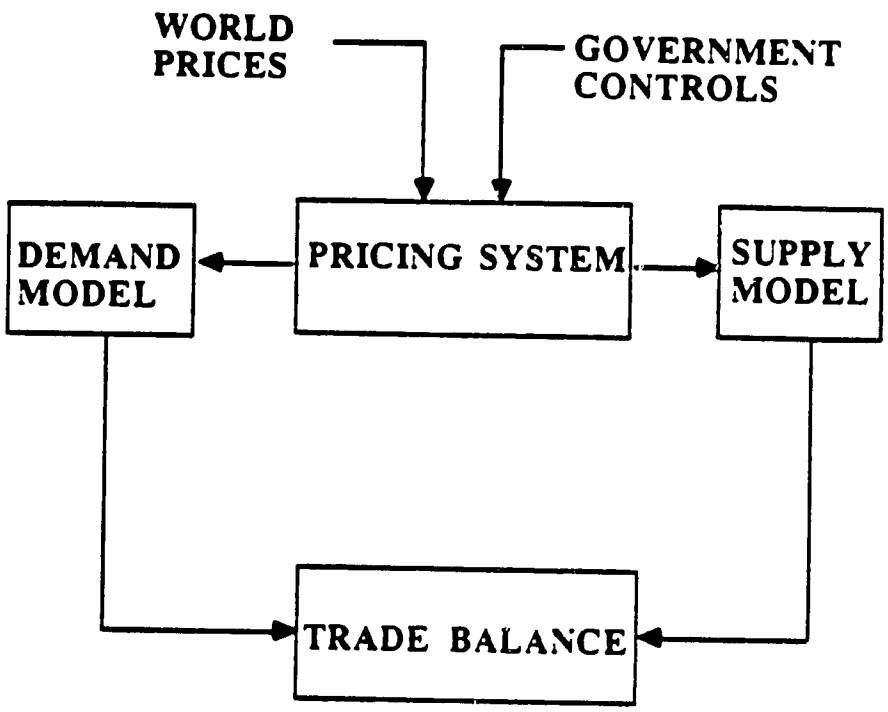

Figure 1. General Model Structure

the demand and supply of agricultural products. To the extent that these resulting supply and demand quantities do not match, incentives exist for imports or exports.

Two key assumptions and simplifications are evident in the structure depicted in Figure 1. The first is that all prices are exogenously determined. In small countries, or countries with significant price controls, this is a realistic assumption. A small country cannot influence world market prices through either its changes in consumption or production. Such a country, therefore, becomes a price taker in the world market. Because of this, many developing countries have a policy of controlling their agricultural prices to partially protect their producers and/or consumers from the instability of the world market. Thus the assumption of exogenous prices appears reasonable for many developing country cases.

A second simplifying assumption is that any imbalance between supply and demand, given the exogenous prices, will result in trade. In actuality, only *incentives* for trade are created which may or may not be fulfilled. These incentives may be constrained by government intervention in the form of quotas, tariffs, and/or lack of foreign currency due the economy-wide general trade balance. Thus, the supply/demand imbalance generated by the exogenous price situation should realistically be viewed as the resulting balance of incentives for trade. To determine actual trade the policies directly affecting trade also would need to be considered.

Figure 2 develops in more detail the structure diagramed in Figure 1. The retail, wholesale, and farm level market, as well as government policies influencing these three market levels and their link to the world market are considered. World prices are directly linked to the wholesale price. Depending

Figure 2 develops in more detail the structure diagramed in Figure 1. The retail, wholesale, and farm level market, as well as government policies influencing these three market levels and their link to the world market are considered. World prices are directly linked to the wholesale price. Depending on the size, efficiency, and distortions in the market in question, a country's wholesale price may be a few percentage points above the world market price for imports and a few percentage points below the world market price for exports. The primary cause of the spread is the marketing cost and profit involved in importing and exporting. A government tax or subsidy on imports or exports can drastically change the wholesale/world market price spread. An export tax in essence adds a marketing expense. As a result, the exporting company will reduce its domestic wholesale purchasing price and widen the wholesale/world price spread to cover this cost. Likewise, a subsidy on an export would allow the wholesale exporter to pay more for the domestic product and still cover his costs. In fact a large subsidy could result in the domestic price of an export product exceeding the world price. Similar logic can be used to deduce the effect of taxes and subsidies on imports.

Wholesale prices are linked to retail and farm level prices by marketing/processing spreads. This spread is essentially equal to the marketing and processing cost for the product, plus a profit margin. However, if the government intervenes to tax or subsidize the commodity in question, the spread between these markets will be affected in the same manner as discussed for the import/export market.

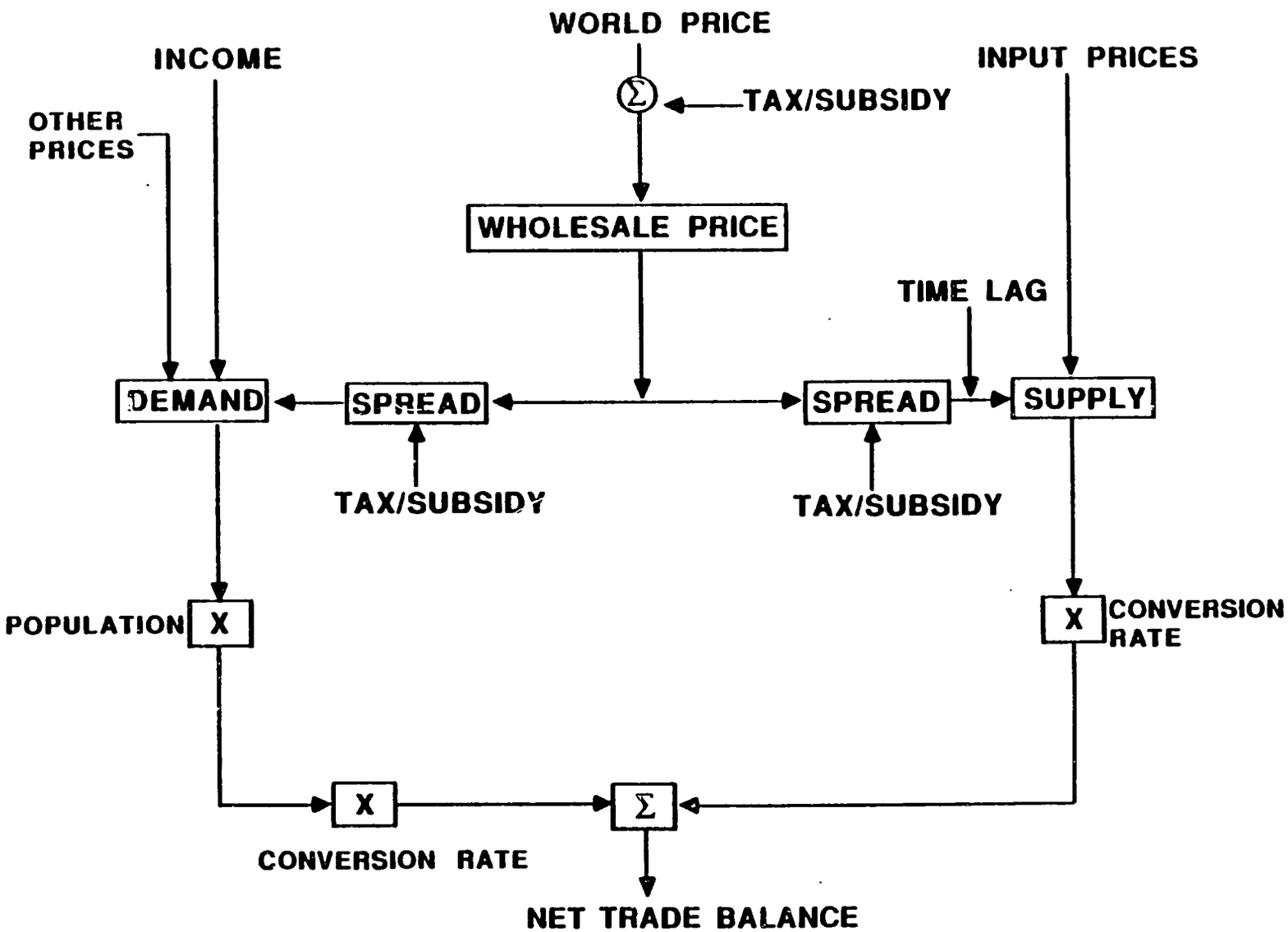

FIGURE 2. Detailed Model Structure

In modeling the market spread between market levels one must also consider that the physical units may be changed by processing. Rice may be milled and animals slaughtered. Physical changes in the units involved are denoted in Figure 2 by the presence of "conversion rate" variables.

Modeling of supply response needs to consider in many cases that supply does not adjust immediately to price changes because of the biological time involved in production. Today's changes in supply may be the result of past price changes. Supply may be influenced by input prices as well as output prices. Input prices more often than product prices are exogenous to the agricultural sector market. If input prices are not set by government, they are generally exogenous to the agricultural sector because they are determined by markets outside of the agricultural sector. Because of their exogenous nature, input prices can be stable as agricultural demand for inputs varies.

Demand is generally modeled as per capita demand and is specified to be a function of its own price, the price of other substitute and complimentary goods, and income. Multiplication of per capita demand by population will give total retail demand. Use of a physical conversion factor, if necessary, will convert retail quantity to wholesale and/or farm level quantities.

The existence of other competing and complementary food prices in the demand model, and input prices in the supply model (which may also be prices of other agricultural products) raises an issue with regard to modeling the total agricultural sector. Figure 2 only depicts the model structure for one commodity. For a sector model, a structural model needs to be specified for all major agricultural commodities in the sector. These individual models in turn need to be linked together through common prices. As long as all prices are assumed to be exogenously determined this linkage is relatively straightforward. Methods for modeling this linkage will be discussed in detail later.

The general econometric model structure described above has several advantages and disadvantages. The assumption of exogenous prices if reasonably realistic is a major advantage because it avoids complexity in the computerization and solution process. Endogenous price determination can be modeled with a spreadsheet program but much of the simplicity and power of the spreadsheet approach is lost.

A second advantage of the described model structure is the large number of policy variables it allows in a relatively simple model. For example, the impact can be considered of import and export taxes and subsidies, producer price supports, input subsidies, consumer price subsidies and taxes, self-sufficiency, and even per capita nutritional level.

A third advantage of the described structure and use of a spreadsheet program is the ease with which the model can be developed and implemented, providing either reliable demand and supply elasticities are available on time series data (ten or more years preferably) and/or cross section data exist with which to estimate them. The need for aggregate data or large amounts of cross-sectional survey data, as opposed to limited quantities of firm level data, is one of the distinct disadvantages of this modeling approach and the econometric modeling approach in general. However, several compromises discussed later in the chapter help to alleviate the problem of inadequate data.

Another advantage or disadvantage, depending on the purpose of the analysis, is the focus of the model on short-term (annual) responses to price and policy changes. In general, the model is valid for looking at marginal changes in policy for one to perhaps five years into the future. Long-run impacts of drastic changes in price and policies which change structure cannot be adequately analyzed by the model.

2. *Theoretical Underpinnings.* At the heart of any econometric model is a set of supply and demand responses or elasticities. The modeling approach presented uses elasticities to relate price and quantity changes.

Elasticities are formally defined as shown in equations 1 and 2.

$$E_{own} = \frac{\Delta Qa}{\Delta Pa} \times \frac{Pa}{Qa} \tag{1}$$

$$E_{cross} = \frac{\Delta Qa}{\Delta Pb} \times \frac{Pb}{Qa} \tag{2}$$

The above basic definition of an elasticity can readily be related to the parameters of supply and/or demand equations of the general form Q = f(Pa, Pb). If a linear functional form is chosen, the following relation exists:

$$Qa = a + bPa + cPb \tag{3}$$

Equations 4 and 5 can be derived from equations 1 and 2.

$$E_{own} \times \frac{Qa}{Pa} = \frac{\Delta Qa}{\Delta Pa} \tag{4}$$

$$E_{cross} \times \frac{Qa}{Pb} = \frac{\Delta Qa}{\Delta Pb} \tag{5}$$

$\partial Q/\partial P$ is the continuous equivalent of $\Delta Q/\Delta P$. Knowing this, equations 6 and 7 follow:

$$E_{own} \times \frac{Qa}{Pa} = \frac{\partial Qa}{\partial Pa} = b \tag{6}$$

$$E_{cross} \times \frac{Qa}{Pb} = \frac{\partial Qa}{\partial Pb} = c \tag{7}$$

or alternatively equations 8 and 9 follow:

$$E_{own} = b \frac{Pa}{Qa} \tag{8}$$

$$E_{cross} = c\,\frac{Pb}{Qa}. \tag{9}$$

Likewise, if a double log functional form is chosen and specified as in equation 10, it can be shown that the parameters of the equation are elasticities.

$$Qa = a\,P_a^{b_1}\;P_b^{b_2} \tag{10}$$

$$\frac{\partial Qa}{\partial Pa} = b_1\,a\,P_a^{b_1-1}\;P_b^{b_2} \tag{11}$$

Substituting equation 11 into equation 1 gives equation 12:

$$E_{own} = \frac{b_1\,a\,P_a^{b_1}\;P_b^{b_2}\;Pa}{Pa\;Qa}. \tag{12}$$

Note that the numerator of 12 contains Qa as shown in equation 10. By substituting Q_a into equation 12 to form equation 13 and then cancelling terms, it is apparent that the own-price elasticity is equal to b_1:

$$E_{own} = \frac{b_1\,Qa\,Pa}{Pa\;Qa} = b_1. \tag{13}$$

Likewise, it can be shown by a similar argument that the cross-price elasticity Qa with respect to Pb is equal to the parameter b_2 in equation 10.

$$E_{cross} = \frac{b_2\,Qa\,Pb}{Pb\;Qa} = b_2 \tag{14}$$

In summary, elasticities and slopes of supply (or demand) equations are directly related. Given one, the other can be deduced. Equations 6 and 7 for the linear case, and 13 and 14 for the log linear case, show how all but the intercept/constant parameter of an equation can be deduced given own- and cross-price elasticities and base prices and quantities when computerization is done in the GESS modeling approach. Once the parameters of a linear or log linear function are known the intercept/constant parameter of the respective

equation can be readily determined by equation 15 in the linear case and 16 in the log linear case.

$$a = Qa - bPa - cPc \tag{15}$$

$$a = Qa/\left(P_a^{b_1} P_b^{b_2}\right) \tag{16}$$

The prices and quantities used can be either the average prices and quantities over a period of time or from a specific point in time. It should be noted that income elasticities, partial adjustment coefficients for lagged dependent variables, and price flexibilities (for price dependent functions) can be dealt with using the same methodology as above.

The above procedure for deducing supply or demand equations from own and cross elasticities allows the heart of the GESS Model to be summarized in a matrix of supply elasticities and a matrix of demand elasticities. Using the equations listed above, the entire set of relationships required for an econometric model can be generated in a spreadsheet from two matrices of elasticities and a set of base year prices and quantities.

Supply and demand theory can be used to determine consistent relationships among own- and cross-price elasticities. The use of supply and demand elasticity matrices as the core of the GESS modeling approach can facilitate the incorporation of previous research results and/or general knowledge about elasticities into the model. If previous studies are deemed valid, the elasticity estimates from them may be directly incorporated into the GESS Model. In some cases, a good literature review can substitute for costly data collection and parameter estimation.

Sometimes it is necessary to rely heavily upon subjective knowledge and judgment to obtain the required elasticities. Done correctly, the GESS

Modeling approach together with subjectively applied elasticities can provide much useful information. A review of the literature reveals some similarities or patterns among elasticities for commodities across countries. Thus, the literature from other countries coupled with expert opinion may provide a credible set of own-price elasticities for a given country. Then this procedure can be used along with basic market share information to generate a complete set of supply and demand elasticities.

The results of a model with only judgment-based elasticities can provide two types of valuable information. First, the model can provide estimates of the general order of magnitude of various pricing policy effects. It can draw attention to multicommodity effects not intuitively obvious even to the trained economist. Second, sensitivity testing indicates which elasticities are critical to the model results. Sensitivity testing essentially involves changing one or more of the assumed elasticities by a given amount and observing the changes in the model's results. Attention then can be focused upon obtaining accurate specification of the parameters found to be critical in evaluating the policy in question. The computerized spreadsheet format of the GESS Model facilitates sensitivity testing.

3. Computer Implementation of the GESS Model. Computer implementation of the GESS Model with a Microcomputer Spreadsheet program provides several distinct advantages. The first advantage is that learning to "program" or design models with a spreadsheet is much easier than learning to program with a computer language such as BASIC or FORTRAN. Indeed, the level of expertise required to implement the GESS Model using a LOTUS 1-2-3 spreadsheet program can be obtained in a one to two week workshop or self-taught over a somewhat longer period. Actual implementation

of the model (assuming all elasticities and base period prices and quantities are known) can be achieved in as little as two days, but certainly within two weeks in most cases.

A second advantage is that operation of the model is intuitive and easily learned. It is reasonable to expect that operational familiarity with the model can be obtained in less than a day by someone with no prior computer experience. This is the case because operation of the model becomes essentially a process of changing policy variables, and perhaps elasticity parameters, within what appears on the microcomputer screen as a set of well documented tables. Reading the output of the model involves simply observing computer generated tables. To the model user the process of simulating the impact of various policy changes is one of "modeling by table editing." Tables of policy variables are edited on the computer screen and the computer then automatically makes the necessary calculations to derive new tables of output projecting the impact of the specified policies.

In the presentation that follows a programer/modeler's overview will be given of how to develop a LOTUS 1-2-3 spreadsheet template for a GESS Model. Familiarity with the LOTUS 1-2-3 spreadsheet command and capabilities will be assumed. Those not familiar with LOTUS 1-2-3 commands will, however, be able to understand the essence of the process.

If the reader is interested in constructing an operating demonstration version of the GESS model, a tutorial assisting in this process has been provided in Appendix A. The tutorial does not provide key stroke by key stroke guide to completing a demonstration GESS model. Basic knowledge of LOTUS 1-2-3 is assumed. Key formulas are presented followed by a discussion of the procedure used to copy and replicate these formulas to complete the remainder of the model. The purpose of the tutorial is to provide the reader/programmer

with enough experience and knowledge of the model that they can proceed to develop modified versions of the model suited to their own cases.

The task at hand for the LOTUS 1-2-3 spreadsheet modeler is essentially to link tables of own- and cross-price elasticities with tables of base period prices, quantities, and pricing policy variables so that tables of resulting supplies and demands can be generated. The methodology discussed which links elasticities to equation parameters provides the fundamental procedure for achieving this. These generated tables may then be augmented and reformulated to summarize the results in more meaningful ways, such as in terms of net trade balances, total government costs, and/or revenues.

For the purpose of this illustration a three-commodity model will be assumed. Figure 3 lays out the spreadsheet design for the heart of the model. It contains six basic tables: a Demand Table, Supply Table, Retail Price Table, Farm Price Table, Demand Elasticity Table, and Supply Elasticity Table. The Demand, Supply, Retail Price, and Farm Price Tables each contain five columns of information, (columns A through E), and three rows (one row for each of the three commodities considered). The entries in the tables in capital letters must be user supplied; those in small letters will be calculated by the program. Column A contains row names for the commodities. In reality instead of Q#1, Q#2, etc., these names would be Rice, Corn, Chicken, etc. In Column B base period values are provided by the user or calculated from base period values provided elsewhere in the model. In this case, base period farm and retail prices are calculated by the program from world prices which are user specified elsewhere in the spreadsheet. Provision of world prices and other variables elsewhere in the spreadsheet will be discussed presently. Columns

	A	B	C	D	E
1		RETAIL DEMAND (MILLION LBS)			
2		BASE YEAR	SCENARIO#1	SCENARIO#2	PERCENT CHANGE
3	Q#1	QD_1	s_1d_1	s_2d_1	$(s_2d_1 - s_1d_1)/s_1d_1$
4	Q#2	QD_2	s_1d_2	s_2d_2	$(s_2d_2 - s_1d_2)/s_1d_2$
5	Q#3	QD_3	s_1d_3	s_2d_3	$(s_2d_3 - s_1d_3)/s_1d_3$
6	FARM LEVEL SUPPLY (MILLION LBS)				
7	BASE YEAR		SCENARIO#1	SCENARIO#2	PERCENT CHANGE
8	Q#1	QS_1	s_1a_1	s_2a_1	$(s_2a_1 - s_1a_1)/s_1d_1$
9	Q#2	QS_2	s_1a_2	s_2a_2	$(s_2a_2 - s_1a_2)/s_1d_2$
10	Q#3	QS_3	s_1a_3	s_2a_3	$(s_2a_3 - s_1a_3)/s_1d_3$
11		RETAIL PRICE ($/CWT)			
12	BASE YEAR		SCENARIO#1	SCENARIO#2	PERCENT CHANGE
13	Q#1	rp_1	s_1rp_1	s_2rp_1	$(s_2rp_1 - s_1rp_1)/s_1rp_1$
14	Q#2	rp_2	s_1rp_2	s_2rp_2	$(s_2rp_2 - s_1rp_2)/s_1rp_2$
15	Q#3	rp_3	s_1rp_3	s_2rp_3	$(s_2rp_3 - s_1rp_3)/s_1rp_3$
16		FARM PRICE ($/CWT)			
17	BASE YEAR		SCENARIO#1	SCENARIO#2	PERCENT CHANGE
18	Q#1	fp_1	s_1fp_1	s_2fp_1	$(s_2fp_1 - s_1fp_1)/s_1fp_1$
19	Q#2	fp_2	s_1fp_2	s_2fp_2	$(s_2fp_2 - s_1fp_2)/s_1fp_2$
20	Q#3	fp_3	s_1fp_3	s_2fp_3	$(s_2fp_3 - s_1fp_3)/s_1fp_3$

	F	G	H	I	J	K
		DEMAND ELASTICITIES				EQUATION CONSTANT TERM
		Q#1	Q#2	Q#3	INCOME	
	Q#1	E_{11}	E_{12}	E_{13}	I_1	a_1
	Q#2	E_2	E_{22}	E_{23}	I_2	a_2
	Q#3	E_{31}	E_{32}	E_{33}	I_3	a_3
		SUPPLY ELASTICITIES				EQUATION CONSTANT TERM
		Q#1	Q#2	Q#3	COST	
	Q#1	S_{11}	S_{12}	S_{13}	C_1	b_1
	Q#2	S_{21}	S_{22}	S_{23}	C_2	b_2
	Q#3	S_{31}	S_{32}	S_{33}	C_3	b_3

Figure 3. Core Table Structure of the GESS Model

C and D report the outcomes of alternative scenarios of different policies and/or world price situations. Column E calculates and compares the percentage differences between Scenarios #1 and #2 as reported in columns C and D, respectively. Columns F through J contain the required supply and demand elasticities.

The size of the GESS Model precludes displaying at one time all of the tables of information required. In fact, for a model with many commodities it is usually best to design the program so only one table shows per screen and then use the "page down", "page up", or "page across" keys to move from table to table. In this illustration, actual "paging" breaks Figure 3 into two screens or pages, with the elasticity matrices appearing on a separate page. Figure 4 gives an overview or "screen map" of the tables in this three-commodity GESS Model. For the moment, concentrate only on the tables shown in Figure 3.

The model's operation is centered on the calculation of the values in Column C (or D) and in particular on the calculation of the quantities demanded and supplied, i.e., cells C3, C4, C5, C8, C9, and C10. These cells are calculated using double log functions of the form reported in equation 10. Using LOTUS 1-2-3 notation, cell C3 would be calculated by equation 17.

$$C3 = (K4 * (C13\text{^}G4) * (C14\text{^}H4) * (C15\text{^}I4) * (C68\text{^}J4)) * C71 \qquad (17)$$

For the reader not familiar with Lotus notation the "*" symbol denotes multiplication, and the "^" symbol denotes raising a variable to a power. The letter and number combination variables denote cell locations in the spreadsheet from which values are obtained, i.e. G4 denotes the intersection of

A . . . . . E F . . . . . K

1 Screen 1A (A1 ... E20)* Screen 1B (F1 ... K20)*

Retail Demand Demand Elasticities

Farm Supply Supply Elasticities

Retail Price

Farm Price

20

21 Screen 2A (A21 ... E40)*

Wholesale Price

Net Trade Balance

Wholesale/World Price Margin

Farm/Wholesale Price Margin

40

41 Screen 3A (A41 ... E60)*

Wholesale/Retail Price Margin

World Price

Import/Export Taxes and Subsidies

Farm Level Taxes and Subsidies

60

61 Screen 4A (A61 ... E80)*

Retail Level Taxes and Subsidies

Per Capita Income

Population

Production Cost Index

80

*Values in parenthesis denote the coordinates of the upper left hand and lower right hand corners of the screen in question.

Figure 4. GESS Model "Screen Map."

together with the retail prices given in Column C of the Retail Price Table, i.e. in cells C13, C14, and C15. Each of the prices is raised to the power of the elasticity reported in the top row of the demand elasticity table. K4 is the constant term of the equation. The demand derived (per capita demand) is multiplied by population, as given in the cell C71, to determine total demand.

Cells C4 and C5 can be calculated in a similar fashion to project the demand for Q#2 and Q#3. Use of the supply elasticities in conjunction with farm prices in a similar manner will generate projections of total supply. For example, cell C8 is calculated as follows:

$$C8 = K11 * (C18\hat{}G11) * (C19\hat{}H11) * (C20\hat{}I11) * (C74\hat{}J11). \qquad (18)$$

In viewing Figure 3 and considering the variables and parameters used in equation 17 and 18, it is noted that only the elasticity parameters of equation 17 and 18 must be user provided (recall that capitalized variables in Figure 3 denote user supplied values and the small letters denote program calculated variables). Calculation of the non-user supplied variables/parameters of these equation must be done before the equations can be solved. Calculation of these variables warrants some explanation.

K4 in equation 17 denotes the constant term of the demand function for Q#1. It can be calculated within the program by using equation 16 as derived in the theoretical underpinnings section. In Lotus notation for the spreadsheet depicted in Figure 3, the calculation of K4 is as follows:

$$K4 = (B3/B71) / ((B13\hat{}G4) * (B14\hat{}H4) * (B15\hat{}14) * (B68\hat{}J4)) \qquad (19)$$

Basically equation 19 is calculated using base period values as reported or calculated in column B, and elasticities. B3 / B71 calculates per capita demand

in the base period. By dividing it by the products of the variables and parameters on the right-hand side of the demand equation, less the constant term, the constant term is solved for as explained in equation 16 in the theoretical discussion. Once K4 is calculated, it can be used in equation 17. Sequencing the calculation of K4 before equation 17 is not a problem with LOTUS 1-2-3. It's "natural order" sequencing of calculation will automatically cause K4 to be calculated before the value is needed in equation 17.

Returning again to Figure 3 and equation 17 we see that the values C13, C14, and C15 are internally calculated. These values are the retail prices for the commodities in question. At this point, it should be recalled that all prices are assumed to be exogenous and determined by either the world market or government controls. The internal calculation of C13, C14, and C15 is designed to reflect this assumption. Additional tables must be used to provide information about world prices, price margins, and government taxation/subsidization activities. These tables are provided on screens 2A, 3A, and 4A (see the Screen Map in Figure 4). The structure of these tables is summarized in Figures 5, 6, and 7. Calculation of the farm level and retail prices appearing in rows 13, 14, 15, 18, 19, and 20 respectively requires linking all the data in Figures 5, 6, and 7 together, i.e., screens 2A, 3A, and 4A. The starting point of this linkage is with the World Price data entered by the user in rows 48 to 50 as shown in Figure 6. The Wholesale Price can be calculated from the World Price, given the Wholesale to World Price Margin (found in rows 33-35), and any Import/Export Taxes and Subsidies (found in rows 53-55). Equation 20 shows the calculation of the wholesale price for Q#1 under Scenario #1, i.e. cell C23:

$$C23 = (C48 * (C33 / 100)) * ((100 + (C53 * (B28 / @ABS(B28)))) / 100). \quad (20)$$

	A	B	C	D	E
21		WHOLESALE PRICE ($/CWT)			
22		BASE YEAR	SCENARIO#1	SCENARIO#2	PERCENT CHANGE
23	Q#1	whp_1	s_1whp_1	s_2whp_1	(d - c)/c
24	Q#2	whp_2	s_1whp_2	s_2whp_2	(d - c)/c
25	Q#3	whp_3	s_1whp_3	s_2whp_3	(d - c)/c
26		NET TRADE BALANCE (MILLION LBS.)			
27		BASE YEAR	SCENARIO#1	SCENARIO#2	PERCENT CHANGE
28	Q#1	ntb_1	s_1ntb_1	s_2ntb_1	(d - c)/c
29	Q#2	ntb_2	s_1ntb_2	s_2ntb_2	(d - c)/c
30	Q#3	ntb_3	s_1ntb_3	s_2ntb_3	(d - c)/c
31	WHOLESALE/WORLD PRICE MARGIN (/WHOLESALE PRICE AS A PERCENT OF WORLD)				
32		BASE YEAR	SCENARIO#1	SCENARIO#2	PERCENT CHANGE
33	Q#1	WWM_1	S_1WWM_1	S_2WWM_1	(d - c)/c
34	Q#2	WWM_2	S_1WWM_2	S_2WWM_2	(d - c)/c
35	Q#3	WWM_3	S_1WWM_3	S_2WWM_3	(d - c)/c
36	FARM/WHOLESALE PRICE MARGIN (FARM PRICE AS A PERCENT OF WHOLESALE)				
37		BASE YEAR	SCENARIO#1	SCENARIO#2	PERCENT CHANGE
38	Q#1	FWM_1	S_1FWM_1	S_2FWM_1	(d - c)/c
39	Q#2	FWM_2	S_1FWM_2	S_2FWM_2	(d - c)/c
40	Q#3	FWM_3	S_1FWM_3	S_2FWM_3	(d - c)/c

Figure 5. Screen 2A of the GESS Model

	A	B	C	D	E
41	WHOLESALE/RETAIL MARGIN PRICE (RETAIL PRICE AS A PERCENT OF WHOLESALE)				
42		BASE YEAR	SCENARIO#1	SCENARIO#2	PERCENT CHANGE
43	Q#1	WRM_1	S_1WRM_1	S_2WRM_1	(d - c)/c
44	Q#2	WRM_2	S_1WRM_2	S_2WRM_2	(d - c)/c
45	Q#3	WRM_3	S_1WRM_3	S_2WRM_3	(d - c)/c
46			WORLD PRICE		
47		BASE YEAR	SCENARIO#1	SCENARIO#2	PERCENT CHANGE
48	Q#1	WP_1	S_1WP_1	S_2WP_1	(d - c)/c
49	Q#2	WP_2	S_1WP_2	S_2WP_2	(d - c)/c
50	Q#3	WP_3	S_1WP_3	S_2WP_3	(d - c)/c
51	IMPORT/EXPORT TAXES (-) AND SUBSIDIES (+) (AS A PERCENT OF FARM LEVEL				
52		BASE YEAR	SCENARIO#1	SCENARIO#2	PERCENT CHANGE
53	Q#1	$IETS_1$	S_1IETS_1	S_2IETS_1	(d - c)/c
54	Q#2	$IETS_2$	S_1IETS_2	S_2IETS_2	(d - c)/c
55	Q#3	$IETS_3$	S_1IETS_3	S_2IETS_3	(d - c)/c
56	FARM/LEVEL TAXES (-) AND SUBSIDIES (+) (AS A PERCENT OF FARM LEVEL PR)				
57		BASE YEAR	SCENARIO#1	SCENARIO#2	PERCENT CHANGE
53	Q#1	FTS_1	S_1FTS_1	S_1FTS	(d - c)/c
54	Q#2	FTS_2	S_1FTS_2	S_1FTS_2	(d - c)/c
60	Q#3	FTS_3	S_1FTS_3	S_1FTS_3	(d - c)/c

Figure 6. Screen 3A of the GESS Model

	A	B	C	D	E
61	RETAIL LEVEL TAXES (-) AND SUBSIDIES (+) (AS A PERCENT OF RETAIL LEVEL)				
62		BASE YEAR	SCENARIO#1	SCENARIO#2	PERCENT CHANGE
63	Q#1	RT_1	S_1RT_1	S_2RT_1	(d - c)/c
64	Q#2	RT_2	S_1RT_2	S_2RT_2	(d - c)/c
65	Q#3	RT_3	S_1RT_3	S_2RT_3	(d - c)/c
66			PER CAPITA INCOME		
67		BASE YEAR	SCENARIO#1	SCENARIO#2	PERCENT CHANGE
68		PCI	S_1PCI	S_2PCI	(d - c)/c
69			POPULATION (THOUSANDS)		
70		BASE YEAR	SCENARIO#1	SCENARIO#2	PERCENT CHANGE
71		POP	S_1POP	S_2POP	(d - c)/c
72			PRODUCTION COST INDEX		
73		BASE YEAR	SCENARIO#1	SCENARIO#2	PERCENT CHANGE
74	Q#1	PC_1	S_1PC_2	S_2PC_2	(d - c)/c
75	Q#2	PC_2	S_1PC_2	S_2PC_2	(d - c)/c
76	Q#3	PC_3	S_1PC_3	S_2PC_3	(d - c)/c

Figure 7. Screen 4A of the GESS Model

It is assumed that the Wholesale to World price spread is expressed by the World Pnce as a percentage of the Wholesale Price. Likewise, it is assumed any taxes or subsidies on imports or exports are reported as a percentage of the Wholesale Price, with taxes reported as a negative percent and subsidies as a positive percent.

Briefly, the logic of equation 20 is as follows. In the first term of the equation the World Price C48 is multiplied by the Wholesale Price expressed as a percentage of World Price as reported by the user in cell C33. Because C33 is reported in percentage terms, it must be converted tc a decimal by dividing by 100. Thus, the first term of the equation calculates the Wholesale Price from the World Price.

The second term of the equation modifies the Wholesale Price calculated by the first term based on the effect of any tax or subsidy imposed on international trade. This modification is complicated by the fact that the impact of a tax or subsidy upon the domestic wholesale price is different depending on whether the commodity in question is an import or export. For example, a tax on an export will act like an increase in the cost of exporting and will cause the domestic Wholesale Price to be lowered relative to the World Price. On the other hand, a tax on an import will be an increase in import cost that will be passed on by raising the domestic Wholesale Price. Because taxes are reported as negative values in the Import/Export Tax/Subsidy table, the basic assumption is that all commodities listed are export commodities. If this is not the case, it is necessary to reverse the sign of the tax rate variable. A similar argument exists in the case of a subsidy. The net trade balance for the commodity in question is contained in cell B28. Positive values denote positive trade balances, or net exportation, and negative values denote net importation.

The sign of the trade balance can be determined by dividing it's basic value by it's absolute value, i.e. B28/@ABS(B28). If this yields a negative value, i.e., a - 1, the result can be taken times the basic tax/subsidy rate variable in cell C53 and the sign reversed to reflect the case of an import commodity. If the division yields a+1, multiplication of the tax/subsidy rate by the result will produce the desired effect of not changing the tax/subsidy rate specified. Thus, the operation of the second term of equation 20 ascertains the sign of the net trade variable, modifies the sign of the tax/subsidy rate appropriately, adds the appropriate percentage tax/subsidy to 100, and then converts the value obtained to a decimal by dividing by 100. Thus, the second term becomes the appropriate value for multiplying times the Wholesale Price to reflect the impact of a tax or subsidy on international trade.

Given the Wholesale Price, the Farm Level and Retail Level Prices can be calculated. The procedure is analogous to that used for the Wholesale Price calculation, except it is not complicated by the balance of trade issue. Equation 21 shows the calculation of Farm Price for Q#1 while equation 22 shows the calculation of the Retail Price for Q#1:

$$C18 = (C23 * (C38 / 100)) * ((100 + C58) / 100) \tag{21}$$

$$C13 = (C23 * (C43 / 100)) * ((100 - C63) / 100). \tag{22}$$

With the above system of interlinked prices, the effect of any world price change or price policy change will be passed through the entire system, i.e., any World Price or policy variable change made in rows 48 through 65 will change the Retail and/or Farm Prices. These changes in turn will change consumption and production.

To complete the discussion of variables that must be user-provided, several more tables illustrated in Figure 7 must be mentioned. These tables provide values for variables that are exogenous to the agricultural sector. They include tables of values for per capita income, population, and production costs. The specific nature of the production cost variables provided will depend upon the input supply elasticities available.

The tables discussed so far provide for the basic operation of the model. Numerous other tables of information can be derived from them. One that has been derived and reported in rows 28-29 is a net physical trade balance table. The calculation of this table follows directly from the supply and demand tables with account being taken that the physical units at the demand level may be different than the physical units at the farm level. Given the net trade balance table and world price table, it is a simple step to calculate the country's monetary net trade balance for the commodities considered. Likewise, given the various tax rates and subsidy rates and volumes of production, consumption, and trade, as well as the direct government costs and revenues of the various subsidies and taxes can be computed for a tabular summary. Total consumption can be converted to per capita consumption. Given per capita physical consumption and caloric data for the foods in question, per capita caloric consumption can be calculated. Thus, the flexibility of the spreadsheet system allows many additional output summary tables to be added with little or no additional input information being required.

In summary, the concepts presented here for the GESS Model are meant to be illustrative of the basic structure of the GESS Model and its implementation. From this base, many modifications can be developed. For example, additional commodities can be added. The supply response portion of the model can be broken into acreage and yield components. By providing

two matrices of demand elasticities, rural and urban consumption subcomponents can be modeled. Rather than considering two scenarios one year into the future the model can be made to consider a sequence of policies for several years. This can be done by changing the scenario columns to yearly columns and then making the base year for each column the column immediately to its left. The model's basic structure can even be modified to endogenize the price determination process. This could be done with moderate ease for a recursive model structure and is feasible for a simultaneous model structure.

APPENDIX A

This tutorial is designed to guide the reader through the process of developing a Generalized Econometric Spreadsheet Simulation (GESS) Model. To use it, you will need a Lotus template named GESSA, and, of course, a Lotus Program. The GESSA file contains the table headings and initialization data for the 3 x 3 example GESS model discussed.

This tutorial is not designed to provide a key stroke by key stroke guide to completing the sample GESS model contained in the Lotus template referred to above. Rather, it discusses the general nature of the formulas for various tables of the Model and indicates the Lotus commands to use in completing the model table by table. Therefore, a basic knowledge of Lotus 1-2-3 is assumed.

The GESSA File

The GESSA template file contains all the table headings and initial data the user must supply to build a 3 x 3 GESS Model. Load the file and use the "PgUp," "PgDn," and horizontal page key (just above the Ctrl key) to look through the spreadsheet and see what data are supplied. The overall spreadsheet design and tables within it are described in Figure 4. A mental note should be made because this is the data the modeler would have to provide if he or she were starting a new model for a different country or set of commodities. Briefly, requirements are the base year data for retail demand, farm supply, price margins, world price, population, income, production cost, conversion factors, and demand and supply elasticities. The demand and supply elasticities are probably the most difficult of the required initial data to provide. They must be determined either through literature review, estimation by regression analysis, or as a last resort, by subjective judgment. Exogenous

data and policy control variable values are also provided for Scenarios #1 and #2 so that all equations developed will have test data available. However, all policy variables dealing with taxes and subsidies have arbitrarily been set to zero.

Step #1

First , a formula is provided for the trade balance cell located at B28. This cell basically is determined by the difference between the supply and demand balance. However, since demand is expressed in the model at the retail level and supply at the farm level, they must be transformed to wholesale level physical units before they are added together. The conversion factors for doing this are located in cells B84 ... B86. The equation for B28 is as follows:

(B8*($B84/100)) - (B3*(100/$C84)) (A.1)

Equations for B29 and B30 can be generated by the COPY command. Answers for these three cells should be -433, 1955, and 7144. Cells C28 ... D30 can also be completed with the COPY command. They will generate zero values until more of the model is completed.

Cells E28 ... E30 are simple percent change formulas. The formulas for E28 is given below:

((D28 - C28) / C28)*100 (A.2)

Cells E29 and E30 can be generated by copying cell E28 to them. In fact, the whole E column can be filled by copying cell E28 to the appropriate cells in the column. Do this now. In many cases, you will get a response of ERR when you copy the formula. This error is due to division by zero. This error will disappear

when the spreadsheet is completed and the zeros in columns C and D are replaced.

Step #2

Enter the Wholesale Price formula in cell B23 next. Wholesale prices are calculated from World prices according to the provided Wholesale Market Spreads and any taxes or subsidies in existence. The Wholesale Price formula is specified as follows:

(B48*(B33/100))*((100 + (B53*($B28/@ABS($B28))))/100) (A.3)

This formula is explained in the chapter. Cells B24 and B25 can be filled with the COPY command. The resulting values should be 110, 88, and 55. It should be noted that all cells that contain prices have been formatted for two decimal points using the RANGE FORMAT command. This is indicated by the fact that an (F2) appears in front of the formula for any cell that has been formatted for two decimal places. Cells C23 ... D25 can also be filled by the COPY command. Answers for them should be identical to those in Column B.

Step #3

Enter the formula for Retail Price in cell B13. It is calculated from the Wholesale Price by considering the margin and any taxes or subsidies charged at the retail level. The Retail Price formula is explained in the text regarding equation 22. It appears as follows:

(B23*(B43/100))*((100 - B63)/100) (A.4)

Cells B14 and B15 can be generated by copying cell B13. The prices generated should be 231.00, 158.40, and 88.00 respectively. Cells C13 ... D15

can be filled by copying cell B13 also. They should have identical values to column B.

Step #4

Enter the formula for Farm Price in cell B18. The Farm Price formula is similar to the Retail Price formula and is explained in the text surrounding equation 22. It appears as follows:

(B23*(B38/100))*((100 + B58)/100) (A.5)

Copy the formula to fill the rest of the table. The prices generated should be 66.00, 52.80, and 33.00.

Step #5

Fill in the formula for Retail Demand in cell C3. Cells C3 ... C5 and D3 ... D5 contain demand functions that use the elasticities provided on Screen 1B, i.e., cells F1 ... K20. Cell C3 is described by the following equations. The equation is explained in the text surrounding equation 17.

($K4*(C$13^$G4)*(C$14^$H4)*(C$15^$I4)*(C$68^$J4))*C$71 (A.6)

After you have typed in the formula for C3 the cell should contain the value zero. This is because the variable K4 in the equation is not defined yet. K4 is the equation constant and can be defined from the base period data and elasticities provided. The equation for K4 is explained by equation 19. It appears as follows:

(B3/B71)/((B13^G4)*(B14^H4)*(B15^I4)*(B68^J4)) (A.7)

Cells K5 and K6 can be generated by copying K4 into them. Finally the rest or the Retail Demand Table can be completed by copying cell C3 into the rest of the table.

Step #6

Completion of the Farm Supply Table is done in the same manner as the Retail Demand Table. The formula for cell C8 is as follows:

+$K11*(C$18^$G11)*(C$19^$H11)*(C$20^$I11)*(C74^$J11) (A.8)

The above equation is essentially a supply equation. Its derivation and logic are explained in the text surrounding equation 18 of this chapter. When this equation is entered it will generate a zero because the constant value in cell K11 is undefined. Proceed to cell K11 and enter the formula given below:

+B8/((B18^G11)*(B19^H11)*(B20^I11)*($B74^J11)) (A.9)

Copy the above formula into cells K12 and K13. The calculated intercepts should be 36946, 44938, and 26885. The value in cell C8 should now be 34000. Copy cell C8 into the appropriate cells in the rest of the Farm Supply Table. The values which are generated in Columns C and D should match those in Column B.

Applications

The model is now complete. Save the model under the name GESSB. You may have noted that your disk already contains a file named GESSZ. This file is a completed version of the model which should match your GESSB file if you have correctly followed the steps in this Appendix. You are ready now to run policy scenarios with the model and/or conduct sensitivity tests of the

elasticity values. The suggested exercises that follow are provided to start you thinking in terms of how the model can be used. You are invited to do further experimentation with the use and expansion of the model on your own.

World Price Response

Change the price of Q#1 in Scenario #1 to 110. As a result you should see production of Q#1 rise, consumption fall, and the trade balance switch to that of a net exporter. Note also that the consumption levels and trade levels of Q#2 and Q#3 are changed. It is this type of interaction to which the GESS Model is good at drawing attention to a providing estimates of. However, supply levels of Q#2 and Q#3 are not changed in this case because all supply cross elasticities are assumed to be zero. This case example has drawn approximate parameters and base period data from the American commodity market for beef, pork, and poultry. Very little supply interaction is deemed to exist between these commodities but demand interaction is strong. In most crop commodity cases supply interaction would be expected because crops often compete for the same land.

Elasticity Sensitivity

Leave the Price of Q#1 in Scenario #1 at 110 and note the magnitude of several key values such as net trade of all three commodities and the demand for Q#1. Having done this proceed to change the own-price elasticity for Q#1 in G4 to -.8. Observe the difference this change makes in the responses of the variables observed before.

Taxes and Subsidies

On your own try a number of taxes and subsidies at different market levels. You may want to tax under one Scenario and subsidize under another. Question the direction of changes with regard to whether they are the expected responses to a tax and/or subsidy. One exercise to try is to calculate a tax/subsidy scheme that would make the country "self sufficient" in commodity Q#1, i.e., cause it to have at least a zero balance of trade for Q#1.

Calculating a Monetary Trade Balance

Go to rows 93 to 100 and construct a Monetary Trade Balance Table for Scenario #1 and #2 and a percentage change column for the Monetary Trade Balances. The basic process for doing this is to multiply the Net Trade Balance figures in rows 28 to 30 together with the World Prices.

Another table you may want to construct is the "Net Direct Government Cost" table for all taxes and subsidies considered. This would involve multiplying the appropriate tax and subsidy rates times the appropriate quantities of retail demand, farm supply, and international trade, and then adding the results together to obtain a net government cost.

Other Applications

If you have further interest in the GESS Modeling approach you may wish to obtain and review a copy of the Liberian GESS Model and Dominican Republic Livestock Sector GESS Model. Both of these models contain several structural features and table derivations not shown here. A review of them will provide further illustration of the potential uses of the GESS Modeling approach. The Liberian GESS Model focuses upon rice policy. It describes

supply in terms of both an acreage component and yield component. Additionally the Liberian model has both an urban and rural demand model. The Dominican Republic Model is structured as a recursive model and uses lagged price responses in the supply model. Templates of both models are available from the author.