THE FOOD AID AND FOOD SECURITY ANALYSIS SYSTEM

Jamaica Technical Manual

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JAMAICA TECHNICAL MANUAL:

CONCEPTUAL FRAMEWORK AND SOFTWARE

DOCUMENTATION

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This manual describes the worksheet version of the Food Aid and Food Security Analysis System (FAFSAS) for Jamaica and details the step-by-step procedure of using this analytical system for policy analysis.

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CHAPTER 1

Introduction

Scope and Purpose

This manual describes the worksheet version of the Food Aid and Food Security Analysis System (FAFSAS) for Jamaica and details the step-by-step procedure of using the analytical system for policy analysis. The general purpose of the FAFSAS is to develop a database and analytical system capable of monitoring and evaluating the impacts of changes in the international markets and in domestic policies on food security (e.g., food availability and accessibility) of developing countries, especially the food importing developing countries.

This analytical framework can be used to assess the impacts on domestic food security of changing global agricultural and trade environments as well as trade policies and domestic market policies in the country itself. The analysis provided by FAFSAS can be used to evaluate policy decisions within the country or decisions by donor agencies regarding development assistance or food aid programs. The information will also enhance interagency coordination of food aid and development resources and programs, including analytical linkages to nutritional outcomes of significant dietary changes in recipient countries.

This manual and the accompanying FAFSAS represent a first step in obtaining results by combining worldwide data from the Food Agricultural Policy Research Institute (FAPRI) models with country-specific information. The manual provides the basic tools for successfully using and managing the FAFSAS and includes:

- a conceptual framework and model that combine FAPRI data with country-specific information, described in a series of equations;
- worksheet documentation of the FAFSAS model;
- instructions for conducting various policy analyses using this analytical system.

How to Use the Manual

This manual is divided into four chapters. Chapter 1 details the scope and purpose of the manual. Chapter 2 contains the conceptual framework describing the key equations of the FAFSAS model and covers production, consumption, net trade, and price transmission. Chapter 3 describes the data sources, estimation procedures, and parameter estimates, along with elasticities and validation statistics. Chapter 4 documents the worksheet version of this model and also provides step-by-step instructions for running a simulation. Finally, Chapter 4 includes steps for modifying and updating the worksheet version of the model.

CHAPTER 2

Conceptual Framework and Model

The FAFSAS links a number of individual models; each provides results to be fed into the next model in the system. Figure 1 shows a diagram of the system. The CARD/FAPRI international trade model measures the commodity-specific factors related to production, prices, trade, economic issues, and weather data of major players in the international agricultural markets. Key components of the model are agricultural policies in the United States and European Union, including the U.S. Farm Bill, the Common Agricultural Policy (CAP), and the Lome Protocol. Use of the CARD/FAPRI model allows researchers to translate changes in international exogenous variables into world prices and world production, consumption, and trade patterns. The outcomes then become the primary factors affecting a particular developing country.

A unidirectional flow of causal impact from the world to a country is assumed for a small open economy. Hence, the next step in the system, the country commodity model, takes these outcomes (specifically the equilibrium prices) and translates them into the specific production, consumption, and trade patterns that should be anticipated by a developing country. Consumption patterns are then evaluated with a demand system to formulate the food security impact. In particular, using food composition data and the recommended dietary allowance for each nutrient category, the consumption pattern is translated into nutritional impact. This impact is further disaggregated into population groups according to socioeconomic and demographic groupings. In this way, we can provide possible outcomes that are based on solid, accurate data from an individual developing country to predict how specific population groups will be affected by changes at the world level or the policy level.

The capacity to combine the worldwide data with country-specific information makes the FAFSAS valuable. It allows us to make accurate and dependable recommendations for developing countries that are based on solid information from the modeling system. The rest of this chapter explains the key equations that transform the conceptual framework into an operational model.

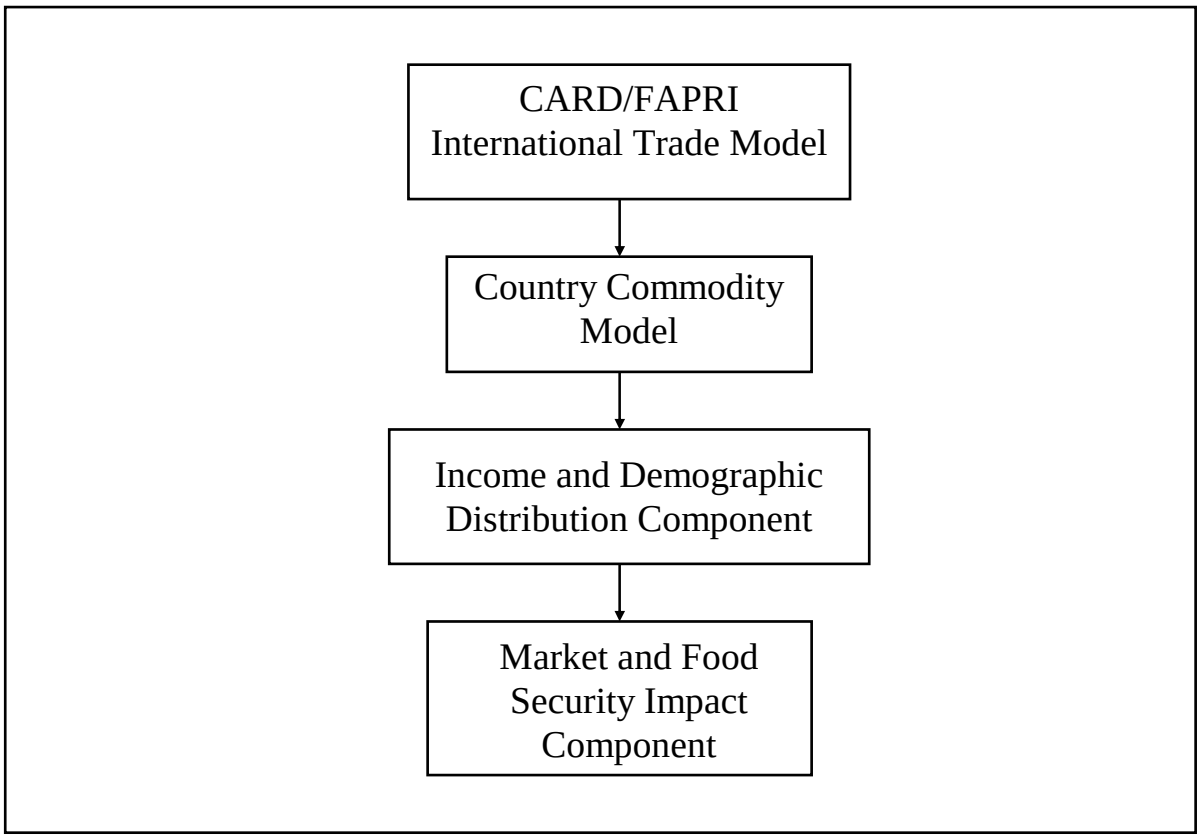


Figure 1. Conceptual Framework of the FAFSAS

Key Equations

CARD/FAPRI International Trade Models

The CARD/FAPRI International Trade Models use a multicountry, multicommodity, nonspatial, and partial equilibrium structure. The structure is nonspatial because country-specific trade flows are not identified and it is partial equilibrium because most nonagricultural sectors and some agricultural commodities are treated as exogenous. The equilibrium price, demand, and net trade quantities are determined simultaneously in the system so that supply and demand are balanced in each country or region and trade is balanced across all countries and regions. The major difference between the CARD/FAPRI International Trade Models and the Country Satellite Model is highlighted later in this section.

The foundation of the CARD/FAPRI International Trade Model includes supply and demand functions for major trading countries and regions. The unique feature of the demand and supply specifications is the incorporation of country-specific domestic and trade policies. The excess demand, in the case of importing countries, and excess supply, in the case of exporting countries, are derived from the country supply and demand functions. These equations are presented here in a general manner.

The Excess Demand of a Net Importing Country

$$[1] \quad ED_i(p,G) = D_i(p,G) - S_i(p,G)$$

where

ED is excess demand,

p is a vector of economic variables (e.g., prices),

G is a vector of government policy variables (e.g., subsidies),

S is supply function,

D is demand function,

i is country index (i = 1, ..., n).

The excess demand functions of all importing countries are summed horizontally across countries for all price levels to derive the aggregate world excess demand for each commodity.

The Aggregate Excess Demand for N-Country Net Importers

$$[2] \quad AED_k(p,G) = \sum_{i=1}^{n} ED_i(p,G),$$

where

AED is aggregate excess demand

k is commodity index.

The same procedure is carried out for the excess supply side in the case of exporting countries to generate the world aggregate supply. Equations [3] and [4] are the supply counterpart of equations [1] and [2].

The Excess Supply of a Net Exporting Country

$$[3] \quad ES_i(p,G) = S_i(p,G) - D_i(p,G),$$

where

ES is excess supply.

The Aggregate Excess Supply for M-Country Net Exporters

$$[4] \quad AES_k(p,G) = \sum_{i=1}^{m} ES_i(p,G),$$

where

AES is aggregate excess supply.

The equilibrium prices, quantities, and net trade are determined by equating the aggregate world excess demand and the aggregate world excess supply. Except where they are set by governments, domestic prices of individual countries are linked to world prices through price linkage equations reflecting bilateral exchange rates and marketing cost margins.

The equilibrium condition for commodity k is the world clearing price; that is, the world price P^W that satisfies equation [5].

The Equilibrium Condition

$$[5] \quad AED_k(p,G) = AES_k(p,G).$$

The CARD/FAPRI trade models have four primary components: (1) U.S. crops, (2) U.S. livestock, (3) international crops, and (4) international livestock.

The impact of the GATT is captured in the trade model through country-specific changes in the policy variable G as a result of the GATT disciplines. The four sections of the GATT agreement relating to international agricultural trade include: (1) market access through tariffication, with commitments to a phased tariff reduction and elimination of nontariff barriers; (2) reduction of export subsidies in both the quantity of subsidized exports and the amount spent to subsidize; (3) phased internal support reduction; and (4) setting minimum sanitary and phytosanitary standards and prohibiting use of sanitary and phytosanitary measures to inhibit trade. Specific country commitments in these areas are captured in the specification of the model equations so that they will have an impact on the outcome of the model solution if they are binding.

Country Commodity Model

The country-specific model is linked to the CARD/FAPRI international trade model for the world price of imported, as well as exported, agricultural products. For a small country that is a price-taker country, the world price together with domestic price policies will drive the production, consumption, and trade patterns of the country. The foundation of the country commodity model is the demand and supply structure specific to the country.

Price Transmission Equations

Price transmission equations provide the bridge between the world price and a country's internal price. The new set of world prices determined in the CARD/FAPRI trade model is transmitted to the Jamaican country commodities model through these price transmission equations. Ideally, the border price in Jamaica differs from the world price by the transportation cost. Since the world price and border price are highly correlated, it is adequate to generate the border price as a function of the world price. For the k^{th} commodity, this is

$$[6] \quad P_k^b = f(P_k^w, ER, C_k),$$

where

P is the border price for the k^{th} commodity,

P^w is the world price for the k^{th} commodity,

ER is exchange rate,

C is marketing cost,

k is the index for commodity.

All domestic prices are expressed in the local currency and the world price is in U.S. dollars. ER is the price of one U.S. dollar in local currency (i.e., the exchange rate). Marketing cost is represented by the variable *C*, which may include markup, transportation, labor, and other marketing costs. Whenever appropriate, the consumer price index is used as a proxy of marketing cost for the price transmission between different levels in the market chain. Also, possible lags and inclusion of other variables in the regression equations will be determined empirically.

Domestic Demand Functions

The aggregate demand includes demand for human consumption, feed use, inventory demand, and demand for industrial use. The dominant component of aggregate demand includes both human and feed use. The quantity demanded for human consumption is expressed as a function of own-price, prices of related commodities (e.g. substitutes and compliments), consumption expenditures, and other shifters (e.g. to account for dynamics and time trend).

$$[7] \quad Q_k^d = f'(p_k, P_s, X, Z_d | \Theta_d),$$

where

Q is the quantity demanded,

p is the own price,

P is a vector of prices of related commodities,

X is real expenditure/income,

Z is a vector of other shifters in the demand equation,

Θ is a vector of demand coefficients,

d superscript and subscript for demand.

Feed demand is a derived demand that is a function of feed price and the livestock price as the major output.

Domestic Supply Functions

The quantity supplied, on the other hand, is expressed as a function of own price, price of inputs, and other shifters:

$$[8] \quad Q_k^s = f\text{`}(p_k, W, Z_s | \Theta_s),$$

where

Q is quantity supplied,

W is a vector of input prices,

Z is a vector of other shifters in the supply equation,

Θ is a vector of supply coefficients,

s superscript and subscript for supply.

The equilibrium condition is given in equation [9], where the net quantity traded (quantity imported or exported) is equal to the difference between the domestic quantity demanded and supplied at the equilibrium price.

Net Trade Equation

$$[9] \quad Q_k^{nt} = Q_k^s - Q_k^d,$$

where

Q is net trade (export if positive and import if negative),

nt superscript for net trade.

For a small open economy, the equilibrium is determined by its domestic demand and supply structure and by international market conditions. If the domestic equilibrium price under autarchy is below the world price, the country is a net exporter of that commodity. On the other hand, if the domestic equilibrium price under autarchy is above the world price, the country is a net importer. In the absence of trade distorting policies, a country has an excess demand (in case of net importers) or an excess supply (in case of net exporters). The country faces a perfectly elastic import supply (for net importers) or export demand (for net exporters) since it cannot influence the world market. In this case, world market prices are fully transmitted to the domestic market. Any price differential between domestic and world prices is fully attributed to transport cost. Figure 2 illustrates the case of a small open economy in the absence of trade distorting policies.

Nutrition Component

The new set of Jamaican prices enter the Jamaican commodity model through the estimated supply and demand equations of the respective commodities (i.e., equations [7], [8], and [9]). The outcomes of the commodity model are per capita consumption patterns of households, production, and trade patterns. The per capita consumption levels of households by commodities will serve as the input in the nutrition component to determine the macro- and micronutrient intake levels. The consumption of products is translated into nutrient intake using

$$[10] \quad TN_l = \sum_{k=1}^{n} \beta_{lk} . Q_k^d ,$$

where

TN is total nutrient intake,

β is the proportion of nutrient per unit weight of commodity consumed,

l is the index for nutrient,

where TN is the total nutrient intake of the l^{th} nutrient, and β_{lk} is the proportion of the l^{th} nutrient (e.g., energy) per unit (e.g., lb) of the k^{th} commodity consumed (e.g., wheat). The vector of n-products (Q with index k) consumed includes wheat, rice, sugar, soy oil, cornmeal, poultry, beef, and pork. The

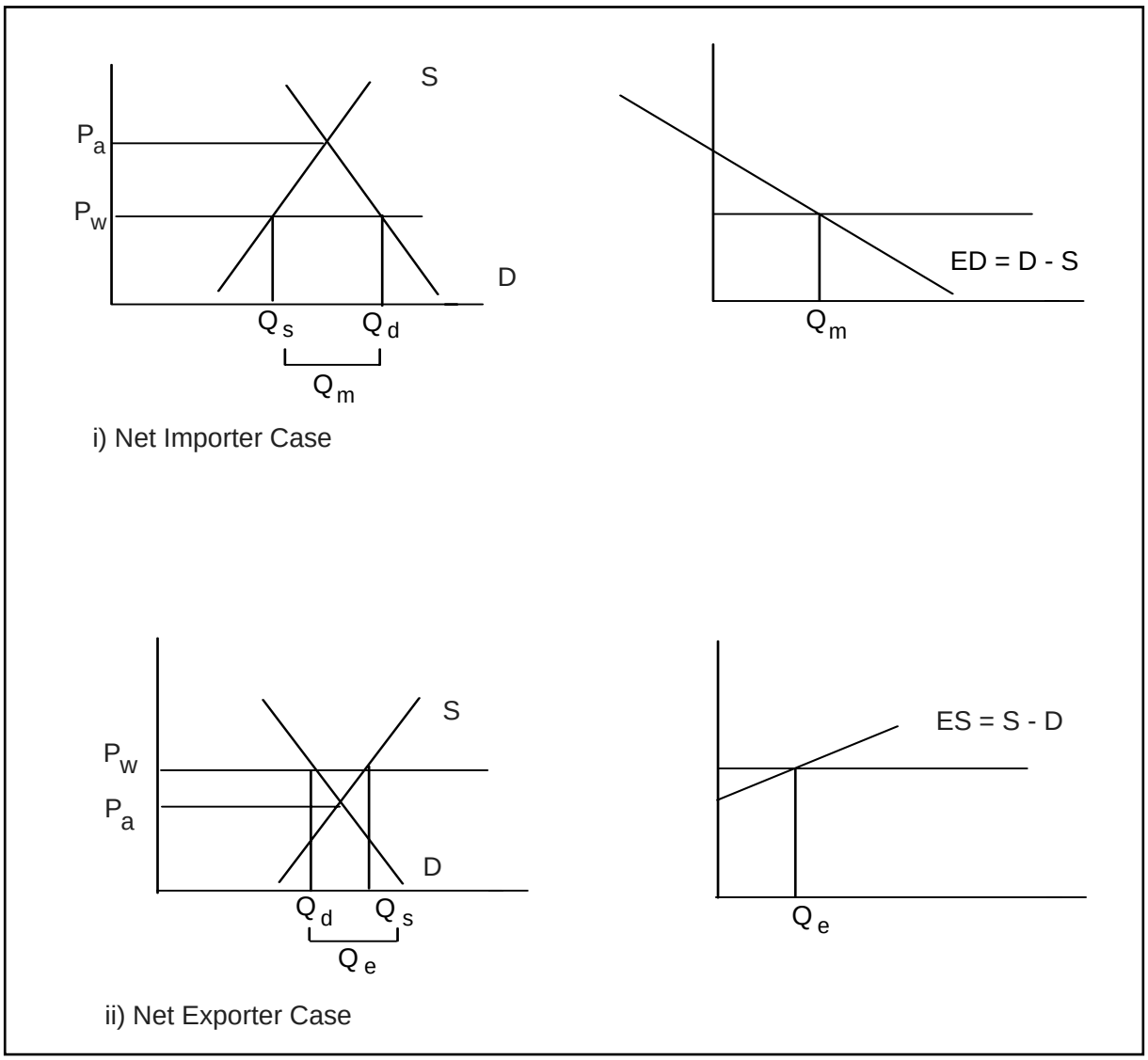


Figure 2. Demand, Supply, and Trade for a Small Open Economy without Trade Distorting Policies

Notes: Pa = autarchy price, Pw = world price.

vector of macro- and micronutrients (the index *l*) includes energy, protein, fat, carbohydrates, fiber, calcium, iron, vitamin A, thiamine, riboflavin, and niacin.

Furthermore, to evaluate the nutritional outcomes of policy changes, the nutrient intake levels are compared with their respective recommended dietary allowances (RDAs) to determine the degree of shortfall (or excess) from the RDAs. To be comparable to the RDA standard, the nutrient intake has to

be expressed on a per day basis. A measure of nutrition adequacy is the ratio of the total intake of nutrient *l* to its corresponding recommended dietary allowance.

The Proportion to RDA Equation

$$[11] \quad ADQ_l = \frac{TN_l}{RDA_l},$$

where

ADQ is a measure of nutrient adequacy,

RDA is recommended dietary allowance.

If this ratio in [11] approaches unity, it implies that the intake of the l^{th} nutrient is adequate in meeting the recommended dietary allowance for that particular nutrient.

Nutrition Component by Socioeconomic and Demographic Population Groups

Different population groups (grouped by socioeconomic and demographic characteristics) are affected differently by changes in the economy (i.e., price changes). Of significant interest is population grouping by income. Other than possible differences in taste and preference between low- and high-income groups, their responses to price changes will also differ due to different proportions of expenditure for the commodities in their food basket and different income elasticities. The nutritional impact on households disaggregated further into socioeconomic and demographic characteristics is examined. The nutrition measures in [10] and [11] are reproduced for each of the population groups by socioeconomic and demographic characteristics. That is, the total nutrient intake is:

$$[12] \quad TN_l^h = \sum_{k=1}^{n} \beta_{lk} . Q_k^{d,h}$$

where

h is index of household socioeconomic and demographic groupings and the ratio of total nutrient intake to RDAs is:

$$[13] \quad ADQ_l^h = \frac{TN_l^h}{RDA_l}.$$

The added index *h* represent the h^{th} household group based on socioeconomic and demographic characteristics. The key groupings are based on income. Different price and income elasticities are

derived for each income group. Differential price and income elasticities of households in different income groups drive the differences in the consumption and nutritional impacts.

Consumption and nutrition impact are also analyzed for household groupings based on geographical location, family size, and head of household characteristics such as age, gender, and occupation.

Data, Estimation, and Validation

Data Requirement

The data requirements of the model are listed in Appendices A to D. Time series data for a number of variables were needed to estimate the model and generate reasonable demand and supply estimates. The consumption time series was approximated by the disappearance series. The disappearance series is derived as a residual in an accounting identity of the sources and uses of a commodity. Sources of a commodity include current production, imports, and beginning inventory. The uses of a commodity (excluding human consumption) are feed use, industrial use, exports, and ending inventory. Human consumption is calculated by deducting nonfood uses from sources of supply. This approach was used for meat and crops.

Data needed for crop supply were area planted and harvested, total production, yield, and other factors affecting supply such as weather data. Data for meat supply included animal inventory, number slaughtered, and average weight.

Price data for all commodities in the model at all levels in the marketing chain were also needed. These included world price, border price, wholesale price, and retail price. Farm price was also recorded when available. Prices of related commodities (i.e., complements and substitutes) and prices of inputs such as fertilizer and feeds were also collected. Basic macroeconomic data such as population, gross domestic product, exchange rate, and consumer price index were also needed. Policy variables included, in particular, the schedule of external and internal tariffs, producer support, and consumer support. Appendices A, B, and C list the basic data requirements.

Data from the Household Expenditure Survey were needed to examine differences in the expenditure, consumption, and nutrient intake of households at different income levels and in other sociodemographic groups. These data are listed in Appendix D.

The Jamaican data were collected from a number of sources. Most of the domestic production data came from the Economic and Social Survey of Jamaica (various years), an annual publication prepared by the Planning Institute of Jamaica. Production Statistics (various years) of the Statistical Institute of Jamaica also provided production data and wholesale values for some major commodities. Data in this publication came from Commodity Boards and Associations, Agricultural Planning Agencies, the

Ministry of Agriculture, and direct returns from producers—large manufacturing enterprises. Production statistics for processed agricultural products came from the Statistical Digest published by the Research and Programming Division of the Bank of Jamaica. The trade data were collected from External Trade (various years) Parts I and II, Statistical Institute of Jamaica. The raw information summarized in the trade data was collected from declarations of importers and exporters presented to the commissioner of customs and excise, as mandated under the Customs and Exchange Control Act. The retail price data were published in the Consumer Price Index, Statistical Institute of Jamaica. World prices were collected from International Financial Statistics and the USDA Situation and Outlook Reports for various commodities. The Statistical Yearbook of Jamaica, Statistical Institute of Jamaica, was the main source for most of the macro variables.

Other unpublished information was collected from personal visits to various agencies of the Government of Jamaica, including the Ministry of Agriculture, Ministry of Welfare and Labor, Ministry of Finance, and the Bank of Jamaica.

Parameter Estimation

The data cover 1972 to 1993. Since Jamaica is a small importer of most commodities,[1] it faces a perfectly elastic import supply, making the price exogenous as determined by the world market. Border duties and internal taxes simply put a wedge between the world price and domestic price. The demand and supply functions can thus be estimated separately without introducing simultaneity bias in the estimates. The supply equations for commodities with local production were estimated using ordinary least squares (OLS). The demand side of the structural model was treated as a separate block and estimated as a system of equations using Iterative Three-Stage Least Squares. This method gives Maximum Likelihood Estimates at the point of convergence.

Crop and meat demand are specified as an Almost Ideal Demand System (AIDS) specification because of the system's desirable properties. It has a flexible, functional form since it is derived from a second-order approximation of the cost function. When the Stone Price Index is used, the final estimating equation is linear in parameters. Also, it makes it easy to impose demand theoretical properties (i.e., adding-up, homogeneity, and symmetry) through cross-equation parametric restrictions. Furthermore, the systems estimation exploits information from the covariance matrix that improves

[1] This is not the case for the beef and pork supply. However, the production lags in beef and pork lessen the simultaneity.

efficiency of estimates (i.e., SURE-type advantage). Actual estimation was accomplished through SAS and RATS version 4.0.

The standard specification of an AIDS model expresses the expenditure share of each commodity as a function of its own price, prices of related commodities (complements and substitutes), and real expenditure. In our specification, lag values of the expenditure share, lag values of some independent variables, and trend were included to capture dynamic adjustments of consumers. Moreover, the model is reformulated to allow direct estimation of the long-run parameters. The theoretical demand properties were imposed only on the long-run parameters. The estimated parameters for demand systems (crops and livestock), supply systems, and price transmission equations are presented in Appendix F(Tables 1 to 24). Elasticities estimated from these parameters, including differentiated elasticities in crops and meat products by income and demographic groups, are also presented in Appendix G (Tables 25 to 36).

Table 1 shows the estimates of the meat demand and Table 2 the crop demand estimates. The adequacy of the estimated model is reflected by a number of statistics. The estimated model displays all the theoretical demand properties since these were imposed in the estimation. The long-run parameter estimates have correct signs as shown in the elasticities derived from them. That is, own-price elasticities are negative and expenditure elasticities are all positive. Many of the long-run parameters have coefficient estimates that are significant. Also, lagged regressors and trend are significant, suggesting dynamic adjustment of consumers. Table 3 gives estimates of the feed demand for corn and Table 4 gives estimates of the feed demand for soybean meal.

Tables 5 to 9 present estimates of the supply equations of beef, pork, and poultry. Tables 10 to 12 give estimates of the supplies of sugar and milled wheat. The supply functions show very good fit with R^2, mostly in the high 80 and 90 percent range. Durbin-Watson statistics suggest the absence of strong serial correlation.[2] A joint test for absence of serial correlation with order higher than one using the Ljung-Box Q(r)-statistic accepts the hypothesis that the first r autocorrelation is random with a true value of zero.[3] Parameter estimates are theoretically consistent, giving the expected positive sign for own price and the negative sign for the input price in a standard supply function. Collinearity may be present, especially when the R^2 is high but individual regressors have low t-values. This can be remedied in a number of ways, such as the principal components method. But since the model is primarily for

[2] Some of the D-W statistics are in the inconclusive range. The D-W is not a formal test when lagged values of the dependent variable are in the set of regressors.

[3] Values of the Q(r)-statistics are not reported in the tables.

simulation purposes, this was not pursued. When collinearity is present, estimates are still unbiased but not very efficient.

Tables 13 to 24 give the estimates of the price transmission equations. Linear and logarithmic functions were used according to what was statistically appropriate. The price transmission equations show very good fit with R^2 , mostly in the high 90 percent range. Most of the Durbin-Watson statistics suggest the absence of serial correlation. The absence of serial correlation is also corroborated by the joint test using the Ljung-Box Q(r)-statistic. Parameter estimates are consistent with the expected direction of impact of price change transmission in the market chain. That is, an increase in the world price would increase the price at the border, wholesale, and retail levels. Also, changes in the exchange rate (i.e., devaluation) increase the domestic price.

Elasticity Estimation

Elasticity estimates provide a scale-free measure of demand or supply responsiveness to changes in its arguments (i.e., own price, income, and input price). The sign of elasticity checks whether the minimum requirement of a downward sloping demand and upward sloping supply are met. Tables 25 to 28 give the demand elasticity estimated from the time series. The own-price elasticities are all negative and all the expenditure elasticities are positive. Moreover, the absolute values of the elasticities are within the range reported for these commodities in other studies. Also, differentiated elasticities by population groups were estimated by merging the time series elasticity with disaggregated information from the Household Expenditure Survey. These estimates are given in Tables 29 and 30.

The supply elasticities are shown in Tables 31 to 33. The meat and crop supply elasticities show a positive own-price elasticity and negative input price elasticities. Feed is the major input in meat production and fertilizer in crop production. The price transmission elasticities show a positive price transmission from the world to the border, from the border to wholesale, and from wholesale to retail level (Tables 34 to 36). Prices at the border respond positively to devaluation of local currency. Prices at the wholesale and/or retail level respond positively to increases in the consumer price index, which is used as a proxy of marketing cost.

Validation Statistics

Historical simulation of the model's core equation was employed to validate the estimated model with a selected set of validation statistics. These statistics are presented in Appendix H (Tables 37 to 39). Table 37 shows the mean of actual and predicted values for the core endogenous variables; the mean of the predicted values are very close to the mean of the actual values, suggesting that the model is

adequate. Table 38 shows the prediction error expressed relative to the actual values of the endogenous variables. The first column is the mean of the error. The second column reports the mean of the absolute value of the prediction error. The third column is the root of the mean square error. All three statistics are expressed as a percentage of the actual values of the endogenous variables. Smaller values indicate a good model.

Table 39 decomposes the Mean Square Error (MSE) into three components: bias, variance, and covariance. The second decomposition includes the bias, regression, and disturbance. The latter offers more intuitive appeal than the former. The bias and regression components capture the systematic divergence of the prediction from actual values. Hence, for a good model, the proportion of bias and regression should approach a small number. On the other hand, the disturbance component, which accounts for the random divergence of the prediction from the actual values, should explain a large proportion of the MSE. Its value should approach one.[4]

Conclusion

The data requirements of the model were collected from various sources such as international organizations and local agencies in Jamaica. Estimation was done in SAS and RATS. Standard diagnostics and validation statistics suggest the model's adequacy in capturing changes in the historical data.

[4] In the first decomposition, a good model will have the covariance component approaching one.

CHAPTER 3

Worksheet Documentation

The conceptual framework and estimated parameters, along with elasticities, have been described in previous chapters. This chapter provides detailed information on the installation requirements and use of the worksheet version of the FAFSAS. The discussion assumes that the user is familiar with the basic concepts and operation of DOS and Lotus 123.

Software and Hardware Requirements

The worksheet version of the FAFSAS is in Lotus Release 4 or 5. The requirements to run the FAFSAS model include Windows 3.1 or later version, DOS 3.30 or later version, and Lotus 123 Release 4 or 5.

The hardware requirements are 386 or later model PC, mouse, 24 MB RAM (preferably more), 13.7 Mg Program File, and VGA or better monitor.

Hard Disk Installation

It is recommended that the program file "FAFSAS.WK4" be placed in a separate directory. If a suitable directory does not exist, create one using the DOS MD or MKDIR command. Make certain the DOS prompt is in the root directory of the hard disk (C:). Type: C:>MD \ <directory name> {Enter}.

Choose a directory name of not more than eight characters; we recommend FAFSAS for the name of the directory on the installation command line. After creating a suitable directory, copy the program file into the FAFSAS directory by typing the following:

C:\COPY <drive:\FAFSAS.WK4>

The Program File

The program file (FAFSAS.WK4) accommodates future policy simulation questions. In particular, this program file is designed to examine the impact of changes in international trade agreements such as the GATT, and changes in domestic border policies such as the duty and tax structure.

The program file contains four worksheets. The first is the ***PARAMETER*** worksheet in which the user specifies the parameters of the policy simulation analysis. The second is the ***BASELINE*** worksheet that includes the data that are used in the baseline and the equations that generate the relevant endogenous variables using the baseline data. Third is the ***SCENARIO*** worksheet. It is very similar to the baseline worksheet in terms of its equation structure. The only difference is that the data values in this worksheet will reflect policy analysis as specified in the parameter worksheet. Last is the ***IMPACT*** worksheet, which is composed of three sections. The ***IMPACT 1*** sheet contains change of consumption, production, trade, and nutrition for both crops and livestock. It also includes estimates of demand and nutrition change expressed in percentages, from baseline to scenario for income and demographic groups. This process is continued in the ***IMPACT 2*** sheet to accommodate all population groups. The ***IMPACT 3*** sheet contains estimates for both baseline and scenario actual levels of consumption (by commodity, in pounds) and nutrient intake (by nutrient in kcl, grams, m.grams, and R.E.), by income and demographic groups. The intake levels are also expressed as proportions of RDA.

The last worksheet, ***OUTPUT***, contains the summary tables for world, border, and retail prices; production, consumption, and trade of crops and livestock; and consumption and nutrition impact by quartile, location, gender, age, family size, and occupation. The results are arranged in the form of baseline, scenario, and percentage changes from baseline to scenario for each variable.

How to Go Through the Program File

When the user loads the program file in Lotus 123, the worksheets in the file will appear in the "Worksheet Tab," in the following order: ***PARAMETER, BASELINE, SCENARIO, IMPACT 1, IMPACT 2, IMPACT 3,*** and ***OUTPUT***. To go from one worksheet to another, simply put the mouse pointer inside the desired worksheet destination and click the left button of the mouse. Once you reach the desired worksheet, you can move across columns by holding the left button of the mouse at the appropriate horizontal scroll arrow (left arrow to move left and right arrow to move right), and across rows by holding the left button of the mouse at the appropriate vertical scroll arrow (top arrow to move up and button arrow to move down).

BASELINE Worksheet

The key worksheet in the program file is the baseline worksheet that shows the economic structure of the model. The baseline worksheet is divided into two subsections: the data section and the equation section.

Data Section

The data requirements of the model were discussed in the previous chapter. Among other things, these include price, macroeconomic, consumption, production, import, inventory, feed use, industrial use, and export data.

Also, data from the Household Expenditure Survey were needed to examine differences in the expenditure, consumption, and nutrient intake of households at different income levels in other socioeconomic and demographic groups.

A sample of the data section is presented here. Column A gives the row address of the data series (e.g., number of cattle slaughtered is in row 134). Column B gives the mnemonic names corresponding to each of the data series (e.g., CAKTNJA_ is the name given to the variable number of cattle slaughtered).[5] Column C provides the descriptive name of the data series. Column D is the unit of measure (e.g., Head). Column E gives the source of the data (e.g., JSES is the Jamaica Economic and Social Survey). The actual data begin in Column K for 1972, the start of the series, and extend up to column AF for 1993.

A	B	C	D	E
		DATA		
130			UNITS	SOURCE
131		YEAR		
132				
133		CATTLE PRODUCTION DATA		
134	CAKTNJA_	Number of Cattle Slaughtered	Head	JSES
135	CAKTDJA_	Total Beef Production	000 Lbs	JSES
136	CAKADJA_	Average Carcass Weight Cattle	LBS/Head	JSES

Equation Section

To maintain tractability, this model is solved recursively. That is, the CARD/FAPRI International Trade Model is solved first, then the solution values of the endogenous variables (e.g., world equilibrium prices) are inputted as given data in the solution of the country commodity model. This greatly reduces the model's complexity.

[5] The first two letters refer to the commodity (e.g., CA for cattle), the next three letters refer to the activity (e.g., KTN for number slaughtered), and the last two letters refer to the country (e.g., JA for Jamaica). Mnemonic names are included in the worksheet because they allow easy cross-referencing using the @vlookup function in Lotus 123.

The equation section gives the worksheet address of the equation, the dependent variable, the list of independent variables, estimated coefficients, and the worksheet formula and function that translate the functional form and algebraic relations of the model's equations into worksheet equations.

Coefficient Estimates

The key elements of the equation section are the coefficient estimates. The performance of the entire model rests largely on whether the coefficient estimates are theoretically consistent and statistically acceptable. The coefficient estimates were given in the previous section.

Nutrient Coefficient and RDAs

The nutrient coefficient, which measures the amount of a particular nutrient available from a unit of commodity consumed, is needed to convert consumption of commodities into nutrient intake. This information is taken from Food Composition Tables.[6] To assess the adequacy (or inadequacy) of the nutrient intake for population groups, their level of nutrient intake is compared to the Recommended Dietary Allowance. The RDAs are intended as benchmark numbers that indicate fulfillment of the nutritional needs in ordinary life situations. An adequate nutrient intake level is in the neighborhood of the RDAs.

Model Component Description

Price Transmission Equation. Column A gives the row address of this equation (i.e., row 1). Column C gives the descriptive name of the equation and the endogenous variables. Column D lists all the explanatory variables that include an intercept, log of world price of wheat, and log of exchange rate. Column E gives the coefficient values corresponding to each of the explanatory variables, which in this example are -3.58, 0.74, and 0.99, respectively. Disaggregating the equation into separate rows for each of the explanatory variables has the added advantage of allowing a more detailed examination of which specific variables are significantly affecting the endogenous variable. The computed and actual values are included for comparison purposes. An example of wheat price transmission from world to border is provided below.

[6] The nutrient coefficient for Jamaica is taken from the "Food Composition Tables—For Use in the English-Speaking Caribbean," compiled by the Caribbean Food and Nutrition Institute, Kingston, Jamaica.

A	B	C	D	E
803		Price Transmission Equations		
810		Wheat Flour Price Transmission		
814		Wheat World-to-Border		
815		Double Log		
816		1	Intercept	-3.58
817		2	Log World Price of Wheat	0.74
818		3	Log Exchange Rate	0.99
820		Computed		
821		Adjustment		
822		Computed with Adjustment		
824		Actual		

Production Equation. The structure of this equation is similar to the price transmission equation. It contains the row address of the equation, the dependent variable, list of explanatory variables, and coefficient values. (Column B is left blank.) An example of a livestock production equation, number of cattle slaughtered, is given below.

A	B	C	D	E
1168		Livestock Production		
1175		Number of Cattle Slaughtered		
1177		1	Constant	55.653
1178		2	Dummy1975	25.917
1179		3	Lag Beef Price	0.006
1180		4	Lag1 Number	0.206
1181		5	Lag2 Number	0.063
1182		6	Lag3 Number	-0.177
1184		Computed		
1185		Adjustment		
1186			1	
1187			2	
1188		Total Adjustment		
1189		Computed with Adjustment		
1190		Actual		

Meat Trade Equation. Net trade is the difference between production and consumption. Since net trade is an accounting equation, there are no estimated parameters.

A	B	C	D
1385		Meat Trade	
1389		Beef Trade	
1391	BEP_JA_b	Beef Production	
1392		Beef Production	
1393		Beef Consumption	
1394		Beef Imports	Consumption - Production
1395		Beef Imports with Adjustments	Consumption - Production
1396	BEI_JA_b	Beef Imports with Adjustments	

Nutrient Intake Equation. The consumption values are translated into nutrient intake (e.g., energy) using the appropriate food composition data. Column C contains all the commodities in the household food basket. Column E gives the coefficient that measures the amount of nutrient (e.g., energy) derived from the consumption of a unit (e.g., one lb) of a commodity (e.g., beef). The sum of nutrient intake over all commodities consumed gives the total nutrient intake. Since this total nutrient intake is compared with the RDA values for each nutrient, it is expressed on a per day nutrient intake basis.

A	B	C	D	E
1801		Average Nutrient Intake		
1804		Energy Intake		
1805	BEENPJA_b	Beef	ENBF	1016
1806	HPENPJA_b	Pork	ENPK	980
1807	CKENPJA_b	Chicken	ENCK	815
1808	WHENPJA_b	Wheat Flour	ENWT	1674
1809	REINPJA_b	Rice	ENRC	1647
1810	SUENPJA_b	Sugar	ENSG	1692
1811	SOENPJA_b	Soy oil	ENSO	3850
1812	CMENPJA_b	Cornmeal	ENML	1651
1813	ENPJA_b	Total Per Capita Daily Intake Energy		

Proportion of RDAs Equation. The nutrient intake is compared to the recommended dietary allowance to evaluate the nutritional adequacy of the consumption of households. The recommended

dietary allowance is the weighted average of the respective recommended dietary allowance by age and gender groups. Column C lists the nutrients included in the model and column E states the RDAs corresponding to each of the nutrients.

A	B	C	D	E
1939		Proportion of Intake to RDA		
1942		RDAs of Nutrients		
1943	ENRDAJA_b	Energy	ENRDA	2239.58
1944	PRRDAJA_b	Protein	PTRDA	43.00
1945	FARDAJA_b	Fat	FTRDA	43.54
1946	CARDAJA_b	Carbohydrate	CRRDA	321.94
1947	CLRDAJA_b	Calcium	CLRDA	678.49
1948	IRRDAJA_b	Iron	IRRDA	11.84
1949	VAARDAJA_b	Vitamin A	VTRDA	551.32
1950	THRDAJA_b	Thiamine	THRDA	0.89
1951	RBRDAJA_b	Riboflavin	RBRDA	1.12
1952	NIRDAJA_b	Niacin	NCRDA	14.99

Income and Demographic Groups

Consumption and nutrition impacts are further disaggregated into consumption and nutrition impact by income and demographic group. The specific categories are:

Income Group

- Quartile 1 - lowest income group
- Quartile 2
- Quartile 3
- Quartile 4 - highest income group

Location of Residence

- Rural
- Urban

Family Size

- 1 to 2
- 3 to 6
- More than 6

Gender of Head of Household

- Male
- Female

Age of Head of Household

- Less than 25
- 25 to 65
- More than 65

Occupation of Head of Household

- Professional
- Self-employed Agriculture
- Self-employed Nonagriculture
- Services
- Others.

***SCENARIO* Worksheet**

The simulation worksheet is structured much like the ***BASELINE*** worksheet. That is, the first section contains the data set and the succeeding rows contain the equations. The main difference is in the data section. Some of the data in the scenario worksheet are conditioned on the specification of the policy simulation analysis entered in the parameter worksheet. The changes in these data will drive the changes in the values of endogenous variables. For example, retail prices in the scenario data section will change if food aid supply is reduced. The degree of price change depends on the amount of food aid reduction and flexibility assumption.

***IMPACT* Worksheet**

The outputs of the policy simulation analysis are contained in the ***IMPACT*** Worksheet. The outputs are presented in terms of the average or representative household/person and in terms of the socioeconomic and demographic groupings. The demographic characteristics include income, which is divided into four quartiles; age, with three categories; location - urban or rural; family size, with three categories; gender of head of household - male or female; and occupation of head of household, with five categories (e.g., self-employed agriculture).

At the mean level, impact outputs include the baseline and scenario values of production, consumption, and net trade for all commodities in the model; nutrient intake; and proportions of the nutrient intake relative to their corresponding RDAs. For the socioeconomic and demographic groups, the impact output is in terms of levels and percentage changes in consumption by commodity, nutrient intake, and proportions to RDAs.

The demand equations for different income and demographic groups are expressed in elasticity form. This is necessary since the additional theoretical property, that is the Slutsky decomposition used to adjust the average elasticity into income and demographic groups, is easily accomplished in elasticity form. Adjusting the average elasticity is the best approach since direct estimation by income and demographic groups is impossible with the limited data from household expenditure surveys. The example shown here (***IMPACT 1*** worksheet) gives the change in demand for wheat for low-income households.

A	B	C	D	E
51		Demand for Quartile 1		
77		Wheat Demand - Quartile 1		
79		1	Change in Price of Wheat	-0.69
80		2	Change in Price of Rice	0.07
81		3	Change in Price of Sugar	0.16
82		4	Change in Price of Soy oil	0.03
83		5	Change in Price of Cornmeal	-0.13
84		Computed		

Without going into the details, once the demand is broken down into population groups by socioeconomic and demographic characteristics, the translation into nutrient intake and proportion of RDAs will follow the same approach as described earlier in the average.

The third section of the ***IMPACT*** worksheet (***IMPACT 3***) shows the impact disaggregated into population groups based on socioeconomic and demographic characteristics.

A	B	C	D	E	F
10			Baseline Consumption		
14			Per Capita Beef Consumption		
15			Per Capita Pork Consumption		
16			Per Capita Chicken Consumption		
17			Per Capita Wheat Flour Consumption		
18			Per Capita Rice Consumption		
19			Per Capita Sugar Consumption		
20			Per Capita Soy oil Consumption		
21			Per Capita Cornmeal Consumption		
173			Baseline Proportion of Intake to RDA		
			Income Quartile		
176			RDAs OF NUTRIENTS		
177	1		Energy	ENRDA	2239.59
178	2		Protein	PTRDA	43.00
179	3		Fat	FTRDA	43.55
180	4		Carbohydrate	CRRDA	321.94
181	5		Calcium	CLRDA	678.49
182	6		Iron	IRRDA	11.84
183	7		Vitamin A	VTRDA	551.32
184	8		Thiamine	THRDA	0.89
185	9		Riboflavin	RBRDA	1.12
186	10		Niacin	NCRDA	14.99

The scenario impact is presented in a format similar to the baseline for Quartile 1 above.

***OUTPUT* Worksheet**

This worksheet summarizes the results from all the worksheets and presents them in a form that can be easily read and interpreted. For each variable, it provides baseline, scenario, and percentage change from the baseline. A sample of the summary table for world prices is presented here.

		1993	1994	1995	1996
5	World Prices Impact (US $/MT)				
7	Baseline Wheat	140.36	144.00	154.66	146.16
8	Scenario Wheat	140.36	144.00	156.00	150.00
9	Percentage Change	0	0	0.86	2.63
11	Baseline Rice	389.15	457.00	328.73	351.02
12	Scenario Rice	389.15	457.00	359.00	372.00
13	Percentage Change	0	0	9.21	5.98
15	Baseline Sugar	220.46	222.31	219.23	219.23
16	Scenario Sugar	220.46	222.31	219.23	219.23
17	Percentage Change	0	0	0	0
19	Baseline Soy oil	479.98	597.00	561.28	500.08
20	Scenario Soy oil	479.98	597.00	563.00	511.00
21	Percentage Change	0	0	0.31	2.18
31	Baseline Corn	118.96	117.00	96.84	101.93
32	Scenario Corn	118.96	117.00	98.00	105.00
33	Percentage Change	0	0	1.20	3.01
35	Baseline Poultry	1217.39	1228.00	1144.06	1174.31
36	Scenario Poultry	1217.39	1228.00	1165.00	1199.00
37	Percentage Change	0	0	1.83	2.00

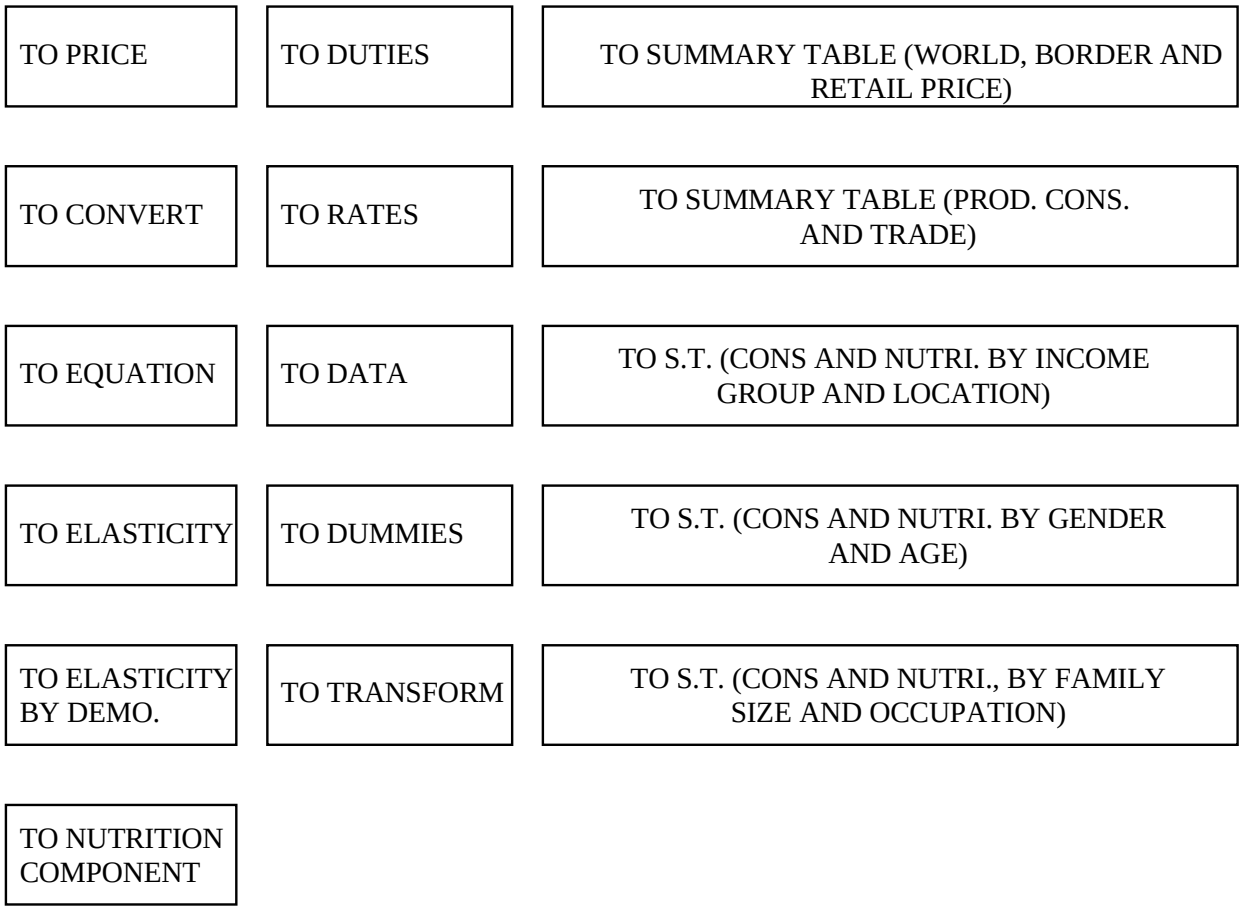
How to Reach the Program Using the Chart

You can also go directly to important sections of the program file by using the chart. Once you load the program file (FAFSAS.WK4) in Lotus 123, you can reach the chart in three simple steps.

1. Press “Alt-F3” (Macro Run will appear on the screen)
2. Type chart (for Macro name)
3. Press “Enter”

You can come back to chart from anywhere in the program file using the same procedure. Once the chart appears on the screen, you can go to a specified location by putting the mouse pointer inside the desired button and clicking the left button of the mouse. For example: If you want to go to data section, put the mouse pointer inside the data button and click the left button of the mouse. Following is a graphic sketch of the structure of the chart along with a brief description of each button.

Chart



TO PRICE: Top of Price Section.

TO CONVERT: Section containing various conversion factors.

TO EQUATION: Equation section

TO ELASTICITY: Section having general elasticities estimates

TO ELASTICITY BY DEMO: Section containing elasticities estimates disaggregated by income groups and demographic characteristics such as income group, location, gender, etc.

TO NUTRITION COMPONENT: Section containing nutrition equations.

TO DUTIES: Contains parameters for policy simulation analysis.

TO RATES: Section that explains tariff structure for various commodities.

TO DATA: Data section

TO DUMMIES: Explains various types of dummies used in the simulation.

TO TRANSFORM: Contains transformed data such budget shares, total expenditures, etc.

TO SUMMARY TABLE (WORLD, BORDER, AND RETAIL PRICES): Presents summary tables for world, border and retail prices.

TO SUMMARY TABLE (PROD., CONS. AND TRADE): Presents summary tables of production, consumption and trade for both crops and livestock.

TO SUMMARY TABLE (CONS. AND NUTRI. BY INCOME GROUP AND LOCAT.): Presents summary tables of consumption and nutrition impacts for different income groups and locations.

TO SUMMARY TABLE (CONS. AND NUTRI. BY GENDER AND AGE): Presents summary tables of consumption and nutrition impacts for various gender and age groups .

TO SUMMARY TABLE (CONS. AND NUTRI. BY FAMILY SIZE AND OCCUP.): Presents summary tables of consumption and nutrition impacts for various family size and occupations.

How to Run the Simulation

Once you load the program file (FAFSAS.WK4) into Lotus 123, go to the chart following the procedure described earlier (press Alt-F3, type: chart, and press Enter).

When you are in the chart, click the button “TO DUTIES.” That will take you to the “DUTY SECTION.”

If you are conducting a pure GATT simulation, then enter 0 in C6 (for GATT) or if you are conducting a GATT run with some changes in the tariff structure, then enter 1 in C6 (for duties).

If you enter 1 in C6, that means you are conducting a simulation with some changes in the tariff structure, and you need to incorporate the new tariffs. Go to the chart and click on the “RATES” button.

Then you type the new tariff values in the “Rate” column. For example: if you are removing the tariffs, enter 0s in the rate column.

After going through steps 1 to 4, simply press F9 to command Lotus to recalculate all the worksheets in the program file. The output generated in all the worksheets is automatically summarized in the OUTPUT worksheet.

CHAPTER 4

Modifying and Updating the Worksheet Program

The worksheet version of the FAFSAS was designed with flexible updating as the primary consideration. Several possible procedures for alterations are discussed in this chapter.

Availability of New Data

The FAFSAS program lends itself to easy updating when new data is available. The existing system covers the period from 1972 to 1993. If data for 1994 and 1995 are made available, all that is needed to incorporate new data into the model is to go to the chart and click the "TO DATA" button. Once you are in the data section, insert two new columns and enter the data for 1994 and 1995. Then, the formulas in the equations simply need to be copied to the added columns and the model will automatically give the new values of all endogenous variables for the added 1994 and 1995 observations.

Reestimation of Equations

If new data for a few years (e.g., three years) are made available, there might be a need to reestimate the coefficients of the model. Updating the data by adding new columns and copying of formulas similar to the procedure described above still needs to be done. Also, the new estimated coefficients have to be inputted into the corresponding equations. That can be done by clicking the button "TO EQUATION" on the chart. In the equation section, all coefficients are in column E; to "cut and paste" the new coefficient estimates only the row addresses of the equations are needed. With the updated data and new coefficients, the model will provide new values of all endogenous variables.

Predicted Values of Exogenous Variables

The solutions of endogenous variables in the CARD/FAPRI International Trade Models are based on many assumed values of exogenous variables such as unilateral policy changes (e.g., CAP Reform), multilateral policy changes (e.g., NAFTA and GATT), and macroeconomic assumptions (e.g., project LINK projections), all of which are updated from year to year. When updated numbers from the CARD/FAPRI models are made available, they can be directly inputted into the appropriate data

addresses. (Go to the data section using the chart and input the new data using the procedure explained on the previous page.)

New Household Expenditure Survey Data

Household expenditure surveys with national coverage are conducted infrequently. When new household expenditure survey data are available, elasticities by socioeconomic and demographic groupings can be adjusted to accommodate the new information. The new elasticities will be entered in the C column of appropriate row addresses of equations in the impact worksheet.

Nutrient Fortification

Nutrient fortification can be easily accommodated in the model by changing the nutrient availability per unit of the commodity consumed. A good example is vitamin A fortification in wheat. This will change the value of vitamin A derived from wheat, which appears in column C.

Additional Commodity Coverage

Increasing the commodity coverage of the model is probably the only change that requires major modification of the worksheet. It calls for appropriate specification of functional form and choice of explanatory variables. Coefficients will have to be estimated. New rows will have to be added to accommodate new functions. The nutrition component will add a new source of nutrients.

Calibrating the Model to Analyze Specific Policy Questions

The model can also be calibrated to analyze specific policy questions that can't be properly captured in the present formulation of the worksheet program. This requires conditioning the values of some of the data in the scenario worksheet to reflect the policy changes. The relevant equations affected by these data will then have to be instructed to feed from this newly constructed data series. The structure of the ***BASELINE*** and ***IMPACT*** worksheets remains as is and captures the effect of the new policy(ies).

APPENDIX A.

Data Requirement of Crop Component

Crop Coverage	Data Requirement Per Crop
1. Wheat	1. Area Planted
2. Corn	2. Yield
3. Rice	3. Beginning Stock
4. Soybeans	4. Imports
5. Soy oil	5. Other Uses
6. Sugar	a. Industrial Use
	b. Feed
	c. Seed
	d. Waste
	6. Exports
	7. Ending Stock
	8. World Price
	9. Border Price
	10. Domestic Farm Price
	12. Domestic Wholesale Price
	13. Domestic Consumer Price
	14. Price Margins
	15. Marketing Costs (e.g., Labor, Transportation, etc)
	14. Conversion Factors (if needed)
	15. Yield Elasticity
	16. Area Elasticity
	17. Own and Cross Price Demand Elasticity
	18. Income Elasticity
	19. Fertilizer Price
	20. Weather (e.g., Rainfall) Data

APPENDIX B.

Data Requirement of Livestock Meat Component

Animal Coverage	Data Requirement per Animal Category
1. Cattle 2. Pigs 3. Poultry	1. Live Animals 1. Breeding Inventory 2. Slaughter Number 3. Mortality 4. Exports 5. Imports 6. Average Live Weight 7. Average Slaughter Weight 8. Farm Price 2. Meat 1. Beginning Stock 2. Imports 3. Exports 4. Ending Stock 5. Live-to-Carcass Conversion Factor 6. Carcass-to-Retail Conversion Factor 7. Farm Price 8. Retail Price 9. Border Price 10. World Price 11. Demand Elasticity (price and income) 12. Supply Elasticity 13. Price of Feed

APPENDIX C.

Macro Data Requirement

Variables And Policies
Variables
1. Population
2. Gross Domestic Product (breakdown)
3. Per Capita Income
4. Exchange Rate
5. Consumer Price Index
6. Tariff Schedule of Major Traded Commodities
7. Schedule of Internal Taxes
Policies
1. Producer Support
2. Consumer Support
3. Research and Development Budget
4. Investment Policies
5. Trade Policies
6. Monetary Policies
7. Fiscal Policies

APPENDIX D.

Data from Household Expenditure Survey

Variables
A. Income Distribution Data
1. Mean Income and Standard Deviation of Income by
Age of Household Head
Occupation
Household Size
Location
2. Proportion of Income Share Received by Each Fifth (or Tenth) by
Age of Household Head
Occupation
Household Size
Location
B. Major Expenditure
1. Proportion of Income Spent on Major Commodities (i.e., Food and Nonfood)
2. Consumer Price Index of Major Expenditure Items
3. Poverty Level Income Threshold
4. Proportion Below Poverty (Poverty Rates)
5. Consumption Expenditure by Household Characteristics
Family Size
Employment
Occupation
Age
Income
C. Food Consumption
1. Quantity of Major Food Commodities Consumed and Proportion of Household by
Household Income
Occupation
Race
Household Size
Location
Composition (i.e., Children)
D. Nutrient Intake
1. Per Capita Nutrient Supply based on Disappearance Data
2. Individual Nutrient Intake Data (if possible by Household Characteristics)
3. Recommended dietary Allowance of Major Macro- and Micronutrients
4. Proportion of Population below RDAs by Major Macro- and Micronutrients

APPENDIX E.

Theoretical Framework of Supply and Demand Functions

Consumers are modeled as maximizing utility subject to some budget constraint. A representative consumer cost function is given in

$$[\text{E1}] \quad \ln C(P,U) = a(P) + b(P).U \,,$$

where

$$[\text{E2}] \quad a(P) = \alpha_0 + \sum_i \alpha_i \ln p_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j$$

and

$$[\text{E3}] \quad b(P) = \beta_0 \prod_{k=1}^{n} p_k^{\beta_k} \,.$$

The demand function is derived using Hotelling's Lemma. That is, taking the first derivative of [E1] gives the Hicksian demand and substituting out U gives the Marshallian demand, the Almost Ideal Demand System (AIDS). The resulting demand function is of the form,

$$[\text{E4}] \quad w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{X}{P}\right)$$

where ln(P) is approximated by a Stone Price Index.

From standard microeconomic theory, the supply function is derived from an indirect profit function. That is,

$$[\text{E5}] \quad \pi(p,y) = p.y - c(y,w) \,,$$

the optimal y* = y(p,w) is substituted in [E5] to get the indirect profit function:

$$[\text{E6}] \quad \pi^*(p,w) = p.y\,(p,w) - c(y\,(p,w),w).$$

The indirect profit function is now a function of output and input prices and other shifters. It is a common result that the first order condition of the indirect profit function with respect to output price gives the supply function, and the first order condition with respect to input price gives the input demand functions. Respectively, the output supply and input demand functions are given in

$$[E7] \quad \frac{\partial p^*(p,w)}{\partial p} = y = y\,(p,w)$$

and

$$[\text{E8}] \quad \frac{\partial \pi^*(p,w)}{\partial w} = x_i = -x_i(p,w)$$

APPENDIX F.

Parameter Estimates

Table 1. Parameter Estimates of Meat Demand

Variable	Coefficient	Standard Error
DEPENDENT		
Share of Beef		
INDEPENDENT		
Constant	0.834	0.172
Log of Price of Beef	-0.077	0.022
Log of Price of Chicken	-0.033	0.020
Log of Real Expenditure	-0.071	0.039
First Difference of Beef Share	0.276	0.042
Second Difference of Beef Share	0.252	0.031
First Difference of Price of Beef	0.054	0.049
First Difference of Price of Chicken	0.014	0.023
First Difference of Price of Pork	-0.050	0.042
Trend	-0.013	0.001
DEPENDENT		
Share of Chicken		
INDEPENDENT		
Constant	-0.336	0.185
Log Price of Chicken	0.093	0.022
Log of Real Expenditure	0.179	0.042
First Difference of Chicken Share	0.222	0.039
Second Difference of Chicken Share	0.165	0.027
First Difference Price of Beef	-0.071	0.053
First Difference Price of Chicken	-0.034	0.025
First Difference Price of Pork	0.073	0.044
Trend	0.012	0.001

Table 2. Parameter Estimates of Crop Demand

VARIABLE	Coefficient	Standard Error
DEPENDENT		
Share of Wheat Flour		
INDEPENDENT		
Constant	-0.362	0.230
Log of Retail Price of Flour	0.081	0.022
Log of Retail Price of Rice	0.053	0.016
Log of Retail Price of Sugar	-0.088	0.020
Log of Retail Price of Soy oil	-0.022	0.009
Log of Real Expenditure	0.121	0.040
First Difference of Wheat	0.352	0.044
Trend	0.003	0.002
DEPENDENT		
Share of Rice		
INDEPENDENT		
Constant	0.122	0.155
Log Retail Price of Rice	0.012	0.032
Log Retail Price of Sugar	-0.062	0.017
Log Retail Price of Soy oil	0.017	0.009
Log of Real Expenditure	0.003	0.027
First Difference of Rice	0.627	0.108
Trend	0.002	0.001
DEPENDENT		
Share of Sugar		
INDEPENDENT		
Constant	1.916	0.334
Log Retail Price of Sugar	0.190	0.030
Log Retail Price of Soy oil	-0.010	0.009
Log of Real Expenditure	-0.264	0.059
First Difference of Sugar	0.236	0.079
Trend	-0.006	0.002
DEPENDENT		
Share of Soy oil		
INDEPENDENT		
Constant	-0.235	0.129
Log Retail Price of Soy oil	0.011	0.008
Log Real Expenditure	0.040	0.022
First Difference of Soy oil	0.591	0.129
Trend	0.002	0.001

Table 3. Parameter Estimates of Corn Feed Demand

VARIABLE	Coefficient	Standard Error
DEPENDENT		
Corn		
INDEPENDENT		
Constant	230817.441	16356.972
Dummy	-90803.371	12742.786
Price of Corn	-21576.107	61222.816
Price of Chicken	35.037	148.385
Price of Corn Lag 1	7202.101	33707.580
Consumer Price Index	-17.254	68.995
TREND	5293.567	2130.520
DIAGNOSTICS		
R-Squared	0.881	
Durbin-Watson	2.233	

Table 4. Parameter Estimates of Soybean Meal Feed Demand

VARIABLE	Coefficient	Standard Error
DEPENDENT		
Soybean meal		
INDEPENDENT		
Constant	-65008.994	69624.217
Price of Soybean meal Lag 1	-9403.812	16553.292
Price of Chicken	39.910	26.795
Quantity of Chicken Produced	1.419	0.572
Quantity of Pigs Produced	0.531	0.540
Trend	-3636.516	2846.709
Dummy One	52616.422	25525.634
Dummy Two	59344.459	26190.951
DIAGNOSTICS		
R-Squared	0.770	
Durbin-Watson	2.710	

Table 5. Parameter Estimates of the Number of Cattle Slaughtered

VARIABLE	Coefficient	Standard Error
DEPENDENT		
Number Slaughtered		
INDEPENDENT		
Constant	55.653	13.780
Dummy	25.917	4.329
Price of Beef Lag 1	0.006	0.001
Number Slaughtered Lag 1	0.206	0.136
Number Slaughtered Lag 2	0.063	0.142
Number Slaughtered Lag 3	-0.177	0.143
DIAGNOSTIC		
R-Squared	0.843	
Durbin-Watson	1.904	

Table 6. Parameter Estimates of the Average Carcass Weight of Cattle

VARIABLE	Coefficient	Standard Error
DEPENDENT		
Carcass Weight		
INDEPENDENT		
Constant	104.500	139.484
Dummy	-98.597	18.408
Price of Beef Lag 1	0.029	0.039
Price of Feed	-19.390	46.065
Carcass Weight Lag 1	0.140	0.176
Carcass Weight Lag 2	0.457	0.226
Number Slaughtered Lag 2	1.080	0.828
DIAGNOSTIC		
R-Squared	0.843	
Durbin-Watson	1.994	

Table 7. Parameter Estimates of the Number of Pigs Slaughtered

VARIABLE	Coefficient	Standard Error
DEPENDENT		
Number Slaughtered		
INDEPENDENT		
Constant	223.523	34.397
Dummy	-32.272	5.325
Price of Pork Lag 1	0.055	0.022
Price of Feed Lag 1	-69.124	24.043
Trend	-0.890	0.547
Number Slaughtered Lag 1	-0.246	0.159
Number Slaughtered Lag 2	-0.248	0.125
Number Slaughtered Lag 3	-0.310	0.145
DIAGNOSTIC		
R-Squared	0.911	
Durbin-Watson	2.021	

Table 8. Parameter Estimates of the Average Carcass Weight of Pigs

VARIABLE	Coefficient	Standard Error
DEPENDENT		
Carcass Weight		
INDEPENDENT		
Constant	251.999	48.575
Dummy	-51.023	8.089
Price of Pork	0.041	0.024
Price of Feed Lag 1	-35.927	28.285
Carcass Weight Lag 1	-0.314	0.112
Carcass Weight Lag 2	-0.334	0.209
Carcass Weight Lag 3	-0.395	0.199
Trend	0.236	0.652
DIAGNOSTIC		
R-Squared	0.912	
Durbin-Watson	2.099	

Table 9. Parameter Estimates of Chicken Production

VARIABLE	Coefficient	Standard Error
DEPENDENT		
Chicken Production		
INDEPENDENT		
Constant	23.215	9.309
Retail Price Chicken	27.843	6.395
Border Price of Broiler Egg	-52.786	23.079
Price of Feed	-119.918	32.549
Chicken Production Lag 1	0.705	0.178
Trend	-1.305	0.766
DIAGNOSTIC		
R-Squared	0.924	
Durbin-Watson	2.810	

Table 10. Parameter Estimates of the Area Planted to Sugar

VARIABLE	Coefficient	Standard Error
DEPENDENT		
Area Planted		
INDEPENDENT		
Constant	55.382	32.480
Trend	-0.735	0.883
Border Price of Sugar (U.K.)	3.169	1.356
Price of Fertilizer	-19.835	9.000
Area Planted Lag 1	0.722	0.200
Annual Average Precipitation	-0.009	0.004
DIAGNOSTIC		
R-Squared	0.949	
Durbin-Watson	2.594	

Table 11. Parameter Estimates of the Yield of Sugar

VARIABLE	Coefficient	Standard Error
DEPENDENT		
Yield		
INDEPENDENT		
Constant	63.515	27.714
Dummy	-2.650	1.092
Border Price of Sugar (U.K.)	1.458	0.710
Price of Fertilizer Lag 1	-14.381	3.127
Yield Lag 1	-0.591	0.228
Yield Lag 2	-0.100	0.210
Trend	-0.721	0.845
Average Rainfall Third Quarter	0.002	0.002
Area Lag 1	-0.035	0.053
Area Lag 2	0.117	0.077
Area Lag 3	-0.054	0.101
Area Lag 4	-0.117	0.101
DIAGNOSTIC		
R-Squared	0.910	
Durbin-Watson	2.565	

Table 12. Parameter Estimates of Wheat Milling

VARIABLE	Coefficient	Standard Error
DEPENDENT		
Wheat Flour Milled		
INDEPENDENT		
Constant	77.936	19.565
Dummy One	135.619	27.239
Border Price of Wheat	-246.411	113.328
Wholesale Price of Wheat Flour	142.107	67.706
Dummy Two	-144.569	30.350
Wheat Flour Milled Lag 1	0.250	0.139
DIAGNOSTIC		
R-Squared	0.909	
Durbin-Watson	2.808	

Table 13. Parameter Estimates of the Price Transmission for Wheat

VARIABLE	Coefficient	Standard Error
WORLD TO BORDER		
DEPENDENT		
Border Price of Wheat		
INDEPENDENT		
Constant	-3.571	0.494
World Price of Wheat	0.788	0.349
Exchange Rate	0.959	0.053
DIAGNOSTIC		
R-Squared	0.954	
Durbin-Watson	1.696	

Table 14. Parameter Estimates of the Price Transmission for Wheat Flour

VARIABLE	Coefficient	Standard Error
WORLD TO BORDER		
DEPENDENT		
Border Price of Wheat Flour		
INDEPENDENT		
Constant	-3.762	0.514
World Price of Wheat	1.198	0.384
Exchange Rate	1.063	0.076
DIAGNOSTIC		
R-Squared	0.921	
Durbin-Watson	3.070	
BORDER TO WHOLESALE		
DEPENDENT		
Wholesale Price of Wheat Flour		
INDEPENDENT		
Constant	0.123	0.029
Border Price of Wheat Flour	0.026	0.057
Consumer Price Index	0.001	0.000
Dummy	1.312	0.193
DIAGNOSTIC		
R-Squared	0.993	
Durbin-Watson	1.009	
BORDER TO RETAIL		
DEPENDENT		
Retail Price of Wheat Flour		
INDEPENDENT		
Constant	-3.284	1.440
Log Border Price of Wheat Flour	0.255	0.153
Lag 1 Retail Price of Wheat Flour	0.189	0.194
Consumer Price Index	0.513	0.208
DIAGNOSTIC		
R-Squared	0.942	
Durbin-Watson	1.378	

Table 15. Parameter Estimates of the Price Transmission for Rice

VARIABLE	Coefficient	Standard Error
WORLD TO BORDER		
DEPENDENT		
Border Price of Rice		
INDEPENDENT		
Constant	-6.107	0.735
World Price of Rice	0.765	0.124
Exchange Rate	0.830	0.023
DIAGNOSTIC		
R-Squared	0.987	
Durbin-Watson	1.843	
BORDER TO RETAIL		
DEPENDENT		
Retail Price of Rice		
INDEPENDENT		
Constant	-3.337	1.235
Log Border Price of Rice	0.242	0.136
Consumer Price Index	0.443	0.253
Trend	0.060	0.034
DIAGNOSTIC		
R-Squared	0.990	
Durbin-Watson	1.960	

Table 16. Parameter Estimates of the Price Transmission for Sugar

VARIABLE	Coefficient	Standard Error
WORLD TO BORDER		
DEPENDENT		
Border Price of Sugar		
INDEPENDENT		
Constant	-0.281	0131
World Price of Sugar	0.005	0.007
Exchange Rate	0.315	0.009
Dummy 83	-0.268	0.128
DIAGNOSTIC		
R-Squared	0.990	
Durbin-Watson	2.270	
BORDER TO RETAIL		
DEPENDENT		
Retail Price of Sugar		
INDEPENDENT		
Constant	0107	0.072
Border Price of Sugar	0.377	0.028
Dummy 82	0.705	0.113
DIAGNOSTIC		
R-Squared	0.956	
Durbin-Watson	1.789	

Table 17. Parameter Estimates of the Price Transmission for Corn

VARIABLE	Coefficient	Standard Error
WORLD TO BORDER		
DEPENDENT		
Border Price of Corn		
INDEPENDENT		
Constant	-3.692	0.125
World Price of Corn	0.904	0.125
Exchange Rate	0.961	0.025
DIAGNOSTIC		
R-Squared	0.988	
Durbin-Watson	1.957	

Table 18. Parameter Estimates of the Price Transmission for Cornmeal

VARIABLE	Coefficient	Standard Error
WORLD TO BORDER		
DEPENDENT		
Border Price of Cornmeal		
INDEPENDENT		
Constant	-2.942	0.435
World Price of Corn	0.938	0.436
Exchange Rate	1.069	0.088
DIAGNOSTIC		
R-Squared	0.894	
Durbin-Watson	2.403	
BORDER TO RETAIL		
DEPENDENT		
Retail Price of Cornmeal		
INDEPENDENT		
Constant	-0.288	0.071
Border Price of Cornmeal	0.231	0.085
Lag 1 Border Price of Cornmeal	0.557	0.075
Dummy 92	1.188	0.198
DIAGNOSTIC		
R-Squared	0.974	
Durbin-Watson	1.730	

Table 19. Parameter Estimates of the Price Transmission for Soybeans

VARIABLE	Coefficient	Standard Error
WORLD TO BORDER		
DEPENDENT		
Border Price of Soybeans		
INDEPENDENT		
Constant	-0.093	0.157
World Price of Soybeans	0.001	0.001
Exchange Rate	0.112	0.003
DIAGNOSTIC		
R-Squared	0.983	
Durbin-Watson	1.921	

Table 20. Parameter Estimates of the Price Transmission for Soybean Meal

VARIABLE	Coefficient	Standard Error
WORLD TO BORDER		
DEPENDENT		
Border Price of Soybean Meal		
INDEPENDENT		
Constant	-0.202	0.248
World Price of Soybean Meal	0.001	0.001
Exchange Rate	0.089	0.006
Dummy	9.933	0.209
DIAGNOSTIC		
R-Squared	0.993	
Durbin-Watson	1.542	

Table 21. Parameter Estimates of the Price Transmission for Soy Oil

VARIABLE	Coefficient	Standard Error
WORLD TO BORDER		
DEPENDENT		
Border Price of Soy oil		
INDEPENDENT		
Constant	-3.511	7.010
World Price of Soybeans	0.019	0.027
Exchange Rate	3.203	0.153
DIAGNOSTIC		
R-Squared	0.959	
Durbin-Watson	1.657	

Table 22. Parameter Estimates of the Price Transmission for Chicken

VARIABLE	Coefficient	Standard Error
WORLD TO BORDER		
DEPENDENT		
Border Price of Chicken		
INDEPENDENT		
Constant	-3.546	0.380
World Price of Chicken	0.749	0.168
Exchange Rate	1.147	0.028
DIAGNOSTIC		
R-Squared	0.992	
Durbin-Watson	0.811	
BORDER TO WHOLESALE		
DEPENDENT		
Wholesale Price of Chicken		
INDEPENDENT		
Constant	-2.733	0.293
Border Price of Chicken	0.261	0.041
Consumer Price Index	0.601	0.045
Dummy	0.299	0.053
DIAGNOSTIC		
R-Squared	0.998	
Durbin-Watson	1.468	
BORDER TO RETAIL		
DEPENDENT		
Retail Price of Chicken		
INDEPENDENT		
Constant	3.169	0.338
Border Price of Chicken	0.532	0.048
Consumer Price Index	0.396	0.052
Dummy	0.236	0.061
DIAGNOSTIC		
R-Squared	0.997	
Durbin-Watson	1.438	

Table 23. Parameter Estimates of the Price Transmission for Beef

VARIABLE	Coefficient	Standard Error
WORLD TO RETAIL		
DEPENDENT		
Retail Price of Beef		
INDEPENDENT		
Constant	-2.176	0.639
World Price of Beef	1.040	0.209
Exchange Rate	0.140	0.114
Consumer Price Index	0.580	0.120
Dummy	0.260	0.090
DIAGNOSTIC		
R-Squared	0.995	
Durbin-Watson	2.650	

Table 24. Parameter Estimates of the Price Transmission for Pork

VARIABLE	Coefficient	Standard Error
WORLD TO RETAIL		
DEPENDENT		
Retail Price of Pork		
INDEPENDENT		
Constant	2.295	2.428
World Price of Pork	0.232	0.422
Exchange Rate	0.834	0.164
World Price of Pork Lag 1	0.300	0.358
Trend	0.080	0.032
Dummy	-0.640	0.148
DIAGNOSTIC		
R-Squared	0.985	
Durbin-Watson	1.713	

APPENDIX G.

Elasticities

Table 25. Marshallian and Expenditure Elasticities for Meat

	Beef	Chicken	Pork	Expenditure
Beef	-0.961	0.294	0.355	0.383
Chicken	0.082	-0.502	-0.103	0.644
Pork	-1.185	0.015	-1.185	0.083

Table 26. Hicksian Elasticities for Meat

	Beef	Chicken	Pork
Beef	-0.528	0.349	0.179
Chicken	0.267	-0.316	0.049
Pork	0.512	0.182	-0.694

Table 27. Marshallian and Expenditure Elasticities for Crops

	Wheat Flour	Rice	Sugar	Soy oil	Cornmeal	Expenditure
Wheat Flour	-0.527	0.101	0.116	0.121	0.064	0.184
Rice	0.233	-0.614	-0.138	0.141	0.289	0.125
Sugar	0.336	-0.022	-0.439	0.050	0.025	0.032
Soy oil	0.380	0.291	-0.189	-0.597	-0.091	0.204
Cornmeal	-0.005	0.483	-0.340	-0.005	-0.282	0.249

Table 28. Unconditional Hicksian Elasticities for Crops

	Wheat Flour	Rice	Sugar	Soy oil	Cornmeal
Wheat Flour	-0.480	0.136	0.160	0.130	0.079
Rice	0.266	-0.589	-0.106	0.147	0.299
Sugar	0.355	-0.008	-0.421	0.053	0.031
Soy oil	0.457	0.350	-0.115	-0.582	-0.067
Cornmeal	0.066	0.541	-0.268	-0.040	-0.260

Table 29. Differentiated Elasticities in Meat Products by Income and Demographic Groups

	Beef	Poultry	Pork
INCOME			
QUARTILE 1			
Beef	-1.202	-0.566	0.234
Poultry	0.131	-0.779	-0.079
Pork	0.947	-0.651	-1.387
QUARTILE 2			
Beef	-1.186	-0.244	0.251
Poultry	0.177	-0.558	-0.053
Pork	0.926	-0.480	-1.391
QUARTILE 3			
Beef	-1.243	-0.148	0.263
Poultry	0.175	-0.496	-0.041
Pork	0.912	-0.361	-1.369
QUARTILE 4			
Beef	-1.323	-0.001	0.281
Poultry	0.174	-0.430	-0.028
Pork	0.868	-0.243	-1.352
AGE OF HEAD			
LESS THAN 25			
Beef	-1.151	-0.118	0.331
Poultry	0.158	-0.562	-0.032
Pork	1.085	-0.168	-1.290

Table 29. (continued)

	Beef	Poultry	Pork
25 TO 65			
Beef	-1.243	-0.097	0.261
Poultry	0.184	-0.469	-0.038
Pork	0.925	-0.308	-1.366
MORE THAN 65			
Beef	-1.331	-0.232	0.200
Poultry	0.162	-0.504	-0.055
Pork	0.830	-0.445	-1.424
FAMILY SIZE			
1 TO 2			
Beef	-1.198	-0.137	0.287
Poultry	0.110	-0.608	-0.062
Pork	0.923	-0.383	-1.360
3 TO 6			
Beef	-1.299	-0.140	0.252
Poultry	0.234	-0.406	-0.017
Pork	0.894	-0.330	-1.369
MORE THAN 6			
Beef	-1.214	-0.155	0.260
Poultry	0.432	-0.142	0.062
Pork	1.009	-0.256	-1.339
LOCATION			
URBAN			
Beef	-1.217	-0.110	0.312
Poultry	0.178	-0.492	-0.027
Pork	1.004	-0.237	-1.313
RURAL			
Beef	-1.288	-0.237	0.202
Poultry	0.182	-0.496	-0.050
Pork	0.824	-0.503	-1.440

Table 29. (continued)

	Beef	Poultry	Pork
GENDER OF HEAD			
MALE			
Beef	-1.241	-0.117	0.253
Poultry	0.179	-0.483	-0.043
Pork	0.892	-0.365	-1.385
FEMALE			
Beef	-1.231	-0.186	0.290
Poultry	0.188	-0.495	-0.029
Pork	0.994	-0.282	-1.325
OCCUPATION			
PROFESSIONAL			
Beef	-1.273	-0.033	0.284
Poultry	0.164	-0.460	-0.035
Pork	0.907	-0.260	-1.349
OTHERS			
Beef	-1.242	-0.114	0.276
Poultry	0.185	-0.474	-0.033
Pork	0.943	-0.298	-1.349
SELF-EMPLOYED			
Beef	-1.239	-0.282	0.158
Poultry	0.193	-0.513	-0.064
Pork	0.810	-0.631	-1.513
SELF-EMPLOYED			
Beef	-1.229	-0.166	0.302
Poultry	0.175	-0.508	-0.030
Pork	1.015	-0.242	-1.313
SERVICE			
Beef	-1.146	-0.204	0.309
Poultry	0.191	-0.543	-0.032
Pork	1.069	-0.237	-1.305

Table 30. Differentiated Elasticities in Crop Products by Income and Demographic Groups

	Wheat	Rice	Sugar	Soy oil	Cornmeal
QUARTILE 1					
Wheat	-0.700	0.083	0.226	0.121	-0.314
Rice	0.075	-0.650	-0.059	0.265	0.423
Sugar	0.164	-0.132	-0.462	-0.083	-0.294
Soy oil	0.034	0.073	0.006	-0.736	-0.202
Cornmeal	-0.126	0.133	-0.082	-0.386	-0.613
QUARTILE 2					
Wheat	-0.668	0.113	0.266	0.146	-0.013
Rice	0.096	-0.630	-0.033	0.283	0.607
Sugar	0.207	-0.092	-0.416	-0.040	0.005
Soy oil	0.038	0.077	0.014	-0.736	-0.134
Cornmeal	-0.087	0.169	-0.044	-0.342	-0.391
QUARTILE 3					
Wheat	-0.615	0.128	0.295	0.177	-0.008
Rice	0.122	-0.629	-0.019	0.286	0.613
Sugar	0.253	-0.081	-0.391	-0.018	0.011
Soy oil	0.048	0.075	0.019	-0.737	-0.131
Cornmeal	-0.055	0.176	-0.027	-0.327	-0.387
QUARTILE 4					
Wheat	-0.574	0.150	0.305	0.230	-0.016
Rice	0.146	-0.622	-0.015	0.310	0.609
Sugar	0.288	-0.068	-0.384	0.019	0.005
Soy oil	0.059	0.080	0.021	-0.725	-0.133
Cornmeal	-0.031	0.185	-0.022	-0.302	-0.391
LOCATION					
URBAN					
Wheat	-0.584	0.134	0.299	0.208	-0.013
Rice	0.139	-0.634	-0.019	0.294	0.612
Sugar	0.278	-0.084	-0.390	-0.001	0.008
Soy oil	0.056	0.075	0.019	-0.731	-0.132
Cornmeal	-0.038	0.175	-0.026	-0.315	-0.389
RURAL					

Table 30. (continued)

	Wheat	Rice	Sugar	Soy oil	Cornmeal
Wheat	-0.650	0.144	0.278	0.192	-0.029
Rice	0.110	-0.609	-0.025	0.315	0.598
Sugar	0.222	-0.064	-0.406	0.000	-0.009
Soy oil	0.044	0.086	0.017	-0.721	-0.138
Cornmeal	-0.081	0.185	-0.039	-0.322	-0.400
FAMILY SIZE					
1 TO 2					
Wheat	-0.657	0.085	0.251	0.182	0.003
Rice	0.090	-0.661	-0.051	0.287	0.621
Sugar	0.206	-0.130	-0.438	-0.024	0.024
Soy oil	0.031	0.058	0.003	-0.740	-0.126
Cornmeal	-0.089	0.142	-0.060	-0.333	-0.378
3 TO 6					
Wheat	-0.611	0.141	0.295	0.180	-0.003
Rice	0.126	-0.618	-0.018	0.293	0.616
Sugar	0.256	-0.071	-0.391	-0.019	0.017
Soy oil	0.052	0.083	0.021	-0.728	-0.131
Cornmeal	-0.053	0.185	-0.026	-0.325	-0.384
MORE THAN 6					
Wheat	-0.605	0.140	0.277	0.234	-0.087
Rice	0.133	-0.614	-0.027	0.335	0.563
Sugar	0.264	-0.068	-0.407	0.039	-0.062
Soy oil	0.057	0.088	0.020	-0.706	-0.149
Cornmeal	-0.052	0.180	-0.041	-0.296	-0.440
GENDER					
MALE					
Wheat	-0.623	0.130	0.280	0.181	-0.020
Rice	0.119	-0.625	-0.027	0.295	0.604
Sugar	0.245	-0.080	-0.405	-0.016	0.000
Soy oil	0.048	0.079	0.016	-0.730	-0.135
Cornmeal	-0.060	0.178	-0.036	-0.323	-0.395
FEMALE					
Wheat	-0.590	0.150	0.305	0.191	-0.012

Table 30. (continued)

	Wheat	Rice	Sugar	Soy oil	Cornmeal
Sugar	0.275	-0.064	-0.383	-0.012	0.008
Soy oil	0.056	0.084	0.023	-0.730	-0.133
Cornmeal	-0.043	0.185	-0.022	-0.331	-0.388
AGE OF HEAD					
LESS THAN 25					
Wheat	-0.998	-0.101	0.115	0.135	-0.250
Rice	-0.144	-0.788	-0.144	0.257	0.446
Sugar	-0.102	-0.293	-0.558	-0.054	-0.214
Soy oil	-0.055	0.015	-0.029	-0.743	-0.198
Cornmeal	-0.235	0.077	-0.111	-0.322	-0.511
25 to 65					
Wheat	-0.873	-0.042	0.209	0.229	-0.156
Rice	-0.045	-0.738	-0.074	0.326	0.515
Sugar	0.005	-0.246	-0.474	0.030	-0.130
Soy oil	-0.037	0.019	-0.010	-0.723	-0.178
Cornmeal	-0.229	0.061	-0.085	-0.296	-0.485
MORE THAN 65					
Wheat	-0.833	0.012	0.237	0.258	-0.127
Rice	-0.020	-0.703	-0.056	0.344	0.533
Sugar	0.014	-0.215	-0.456	0.048	-0.112
Soy oil	-0.002	0.052	0.007	-0.707	-0.162
Cornmeal	-0.286	0.036	-0.093	-0.304	-0.493
OCCUPATION					
PROFESSIONAL					
Wheat	-0.552	0.161	0.307	0.210	-0.015
Rice	0.164	-0.615	-0.014	0.289	0.611
Sugar	0.310	-0.077	-0.390	-0.051	0.014
Soy oil	0.066	0.078	0.020	-0.746	-0.131
Cornmeal	-0.016	0.190	-0.022	-0.325	-0.389
OTHERS					
Wheat	-0.599	0.134	2.97	2.00	-0.002
Rice	0.133	-0.625	-0.018	0.302	0.617
Sugar	0.257	-0.094	-0.396	-0.028	0.024

Table 30. (continued)

	Wheat	Rice	Sugar	Soy oil	Cornmeal
Cornmeal	-0.044	0.182	-0.025	-0.310	-0.383
SELF-EMPLOYED					
Wheat	-0.680	0.140	0.256	0.174	-0.065
Rice	0.100	-0.607	-0.033	0.315	0.579
Sugar	0.173	-0.082	-0.439	-0.046	-0.047
Soy oil	0.042	0.088	0.015	-0.719	-0.145
Cornmeal	-0.105	0.179	-0.056	-0.339	-0.425
SELF-EMPLOYED					
Wheat	-0.605	0.124	0.295	0.211	0.000
Rice	0.128	-0.633	-0.019	0.309	0.619
Sugar	0.250	-0.106	-0.398	-0.014	0.027
Soy oil	0.054	0.080	0.021	-0.718	-0.130
Cornmeal	-0.048	0.175	-0.026	-0.302	-0.382
SERVICES					
Wheat	-0.609	0.112	0.298	0.123	0.024
Rice	0.127	-0.638	-0.016	0.254	0.634
Sugar	0.314	-0.002	-0.361	0.130	-0.011
Soy oil	0.052	0.074	0.021	-0.746	-0.123
Cornmeal	-0.054	0.162	-0.026	-0.370	-0.364

Table 31. Supply Elasticities for Livestock Meat

	Own Price	Feed Price
Cattle		
Number Slaughtered	0.067	
Average Carcass Weight	0.046	-0.019
Pigs		
Number Slaughtered	0.286	-0.262
Average Carcass Weight	0.194	-0.123
Poultry Production*	1.834	-0.951

*Elasticity with respect to broiler egg input is -0.666

Table 32. Supply Elasticities for Sugar Production

	Own Price	Fertilizer Price
Area Planted	0.037	-0.041
Average Yield	0.075	-0.128

Table 33. Supply Elasticities for Local Wheat Milling.

Own-Price (Wheat Flour)	0.173
Input Price (Wheat)	-0.789

Table 34. Elasticities for the Price Transmission Equation from the World to the Border

Border Price	World Price	Exchange Rate
Wheat	0.787	0.959
Wheat Flour	1.197	1.062
Rice	0.764	0.830
Sugar	0.051	1.266
Soybeans	0.219	0.928
Soybean Meal	0.290	0.643
Soy oil	0.267	0.926
Corn	0.903	0.960
Cornmeal	0.938	1.069
Chicken	0.749	1.147

Table 35. Elasticities for the Price Transmission Equation from Border/Wholesale to Retail

Retail Price	Border/Wholesale Price	Consumer Price Index
Wheat Flour	0.255	
Rice	0.245	0.856
Sugar	0.499	
Cornmeal	0.231	
Soy oil	1.000	
Chicken	0.531	0.396
Corn	1.000	
Soybean Meal	1.000	
Poultry	0.532	
Beef	1.040	
Pork	0.232	

Table 36. Elasticities for the Price Transmission Equation from Border to Wholesale

Wholesale Price of Commodity	Border Price	Consumer Price Index
Wheat Flour	0.027	0.645
Chicken	0.260	0.600

APPENDIX H.

Statistics

Table 37. Descriptive Statistics of the Model Simulation

ENDOGENOUS VARIABLE	ACTUAL		PREDICTED	
	Mean	Std. Error	Mean	Std. Error
CATTLE				
Number Slaughtered	68.589	7.075	68.382	6.261
Average Weight	457.538	29.058	456.320	24.829
PIG				
Number Slaughtered	115.208	14.766	114.520	13.112
Average Weight	131.425	20.505	131.245	19.587
POULTRY				
Production, Whole Birds	81.852	21.059	82.576	19.416
MEAT DEMAND				
Share of Beef	0.324	0.061	0.325	0.061
Share of Chicken	0.552	0.088	0.551	0.088
CROP DEMAND				
Share of Wheat	0.293	0.087	0.295	0.072
Share of Rice	0.225	0.042	0.230	0.027
Share Sugar	0.295	0.084	0.291	0.078
Share of Soy oil	0.074	0.025	0.070	0.019
FEED DEMAND				
Corn	289.336	34.441	282.777	42.264
Soybean Meal	124.316	36.675	125.382	27.217
PRODUCTION				
Wheat Flour Production	207.845	87.347	204.975	86.729
Area Planted with Sugar	98.988	8.056	98.943	6.237
Yield of Sugar	24.788	1.379	24.816	1.399

Table 38. Model Statistics of Fit

VARIABLE	MEAN ABSOLUTE		
	Mean % Error	% Error	RMSE %
CATTLE			
Number Slaughtered	-0.041	4.911	5.414
Average Weight	-0.169	2.446	3.041
PIG			
Number Slaughtered	-0.356	2.906	3.750
Average Weight	0.011	2.678	3.339
POULTRY			
Production	1.696	6.901	8.705
MEAT DEMAND			
Share of Beef	0.267	3.543	4.412
Share of Chicken	-0.102	2.403	2.816
CROP DEMAND			
Share of Wheat	4.835	13.007	21.089
Share of Rice	4.467	12.594	15.054
Share Sugar	0.165	12.839	15.054
Share of Soy oil	-0.106	22.104	28.808
FEED DEMAND			
Corn	-2.445	6.379	7.457
Soybean Meal	4.136	14.928	19.714
PRODUCTION			
Wheat Flour Production	-0.757	8.297	12.979
Area Planted with Sugar	0.155	3.273	4.020
Yield of Sugar	0.123	1.261	1.737

Table 39. Theil Forecast Statistics

VARIABLE	Corn	Bias	Reg	Dist	Var	Cov
CATTLE						
Number	0.850	0.003	0.004	0.992	0.047	0.949
Average Weight	0.866	0.008	0.001	0.992	0.084	0.908
PIG						
Number	0.951	0.023	0.039	0.938	0.123	0.854
Average Weight	0.975	0.002	0.008	0.990	0.040	0.958
POULTRY						
Production	0.953	0.014	0.011	0.976	0.065	0.921
MEAT DEMAND						
Share of Beef	0.973	0.003	0.026	0.971	0.002	0.995
Share of Chicken	0.985	0.002	0.007	0.991	0.000	0.998
CROPS DEMAND						
Share of Wheat	0.912	0.006	0.038	0.956	0.164	0.830
Share of Rice	0.517	0.027	0.024	0.949	0.157	0.816
Share Sugar	0.836	0.008	0.033	0.959	0.012	0.980
Share of Soy oil	0.577	0.043	0.052	0.904	0.070	0.887
FEED DEMAND						
Corn	0.876	0.099	0.312	0.589	0.130	0.771
Soybean Meal	0.747	0.002	0.000	0.998	0.150	0.848
PRODUCTION						
Flour Production	0.960	0.015	0.013	0.972	0.001	0.985
Sugar Area	0.868	0.000	0.034	0.965	0.200	0.800
Yield of Sugar	0.949	0.004	0.040	0.955	0.002	0.994

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