The Agricultural Component in Macroeconomic Models

By William E. Kost*

Abstract

Many of the operational macroeconomic models examined either ignore or treat the agricultural sector as exogenous When the sector is treated as endogenous, it is most likely structurally misspecified and/or too small to provide much information about agriculture Given the increased awareness about economic interdependence among sectors, the importance of agriculture, the growing demand for more detailed forecasts, and the growing elaboration of econometric models, both agricultural economists and macroeconomists should direct more attention to making agricultural sectors of macroeconomic models endogenous

Keywords

Macroeconomic models, Agricultural sector models, Model linkage

The last decade has witnessed a proliferation of econometric models, especially macroeconomic models Macroeconomic modeling efforts have been increasingly used to forecast future economic behavior and to analyze the impacts of alternative economic policies This trend has been accompanied by a growing awareness of the inter relationships between the various sectors of an economy and between different national economies This situation is particularly true for agriculture

With high rates of inflation and reduced real income growth, food becomes a more important part of the consumer budget As agriculture becomes more industrialized and, therefore, depends more on nonagricultural inputs, the demand for the products of many industries depends increasingly on the economic well-being of the agricultural sector With rising raw materials and energy prices and the reduced economic independence of both the agricultural sector and the national economies, agricultural markets depend increasingly on policies in the rest of the economy As world population grows, food demand grows For countries with large or growing populations, domestic food demand becomes increasingly important Thus, for exporters or importers of agricultural products, agriculture becomes increasingly important

In this article, I evaluate the impact these changes have had on macroeconomic modeling. Only recently have enough preconditions existed to make such a study relevant First, agriculture must be important (or be perceived as important) before agricultural details should be incorporated into macroeconomic models Second, macroeconomic models should provide (or potentially provide) some benefits to decisionmakers prior to any consideration of expanding or modifying them to provide agricultural detail Finally, enough macroeconomic models in current use should be documented in sufficient detail to show just how agriculture is currently treated Only then can we evaluate the appropriateness of the model specification to capture the agriculture/nonagriculture interaction or can we make recommendations on how models can be modified to capture this interaction better A survey of the specifications of the agricultural block of several macroeconomic models allows me to evaluate the appropriateness of these specifications and to make recommendations on the direction of future research [1]

The Importance of Agriculture to the National Economy

The concern about agriculture/nonagriculture interrelationships results largely from an increased awareness of the feedbacks inherent in economic systems Macroeconomic models provide endogenous values for those variables—such as disposable income—that drive separate agricultural sector models These variables are deter-

*The author is an agricultural economist with the International Economics Division, ERS He wishes to thank Clark Edwards, Vernon Roningen, and an anonymous reviewer for their helpful comments

[1]A study of the modeling interrelationship between agriculture and the rest of the economy can be evaluated from two perspectives How has agriculture been incorporated into macroeconomic modeling? How have nonagricultural factors been incorporated into agricultural models? The Subotnik paper (*19*) takes this latter approach Italicized numbers in parentheses refer to items in the references at the end of this article

minants both of consumer demand for food and of factor supply of agricultural inputs Enclosing the agricultural sector in a macroeconomic model allows us to conduct an endogenous examination of these feedbacks Macroeconomic models are also based on national account concepts and identities that are aggregations across sector components Thus, agriculture is crucial to the complete specification of any macroeconomic model Any significant change in one component changes the sum, and changes in the agricultural sector are frequently significant enough to affect national aggregates There are several other reasons why sectoral detail should be included in macroeconomic models Many macroeconomic model clients (policymakers, businessmen, social scientists, and others) are interested in the performance of specific sectors of the economy—including the agricultural sector—as well as in the performance of the total economy This interest is partially generated because policy stimulus responses differ among sectors Furthermore, many public policy proposals are themselves sector specific These sector policy proposals can be explicitly simulated only if the model has explicit sector specifications

These above arguments imply that at least a few individual sectors should be explicitly included in macroeconomic models One would hope that forecast accuracy will improve if sector detail is included, although it need not The principle argument for including sector detail hinges on an interest in sector performance If detail is to be included, and if one views macroeconomics from an aggregation perspective, then appropriate feedback mechanisms must be included, each type of variable should both affect and be affected by the other type of variable

The relevant question then becomes How important are the various sectors to the total economy? If a sector is not important, there will be little feedback from that sector to the macroeconomy However, if that sector is important, there will be significant feedback and the details of that sector should be modeled Therefore, the initial issue is the importance of agriculture to the total economy

I have already alluded to the growing importance of primary products, particularly agriculture I will now attempt to quantify the relative importance of agriculture to the total economy in countries for which operating macroeconomic models already exist

Many criteria can be used to measure agriculture's importance to the total economy In many countries it accounts for a significant portion either of total production or of total consumption If agriculture is not important from these viewpoints, it may still be an important component of a country's international trade If so, it should be explicitly included in a macroeconomic model The way agriculture's importance to a country is defined indicates just how the agricultural sector should be specified

Table 1 shows the relative importance of agriculture to the total economy of 13 countries Australia, Austria, Belgium, Canada, Finland, France, Italy, Japan, the Netherlands, Sweden, the United Kingdom, the United States, and West Germany The data show the relative importance of agricultural production, consumption, imports, and exports to total production, consumption, imports, and exports for the 1960-75 period These 13 countries represent the Project LINK countries documented in (*20*) The time period covers most of the sample period over which the LINK models were estimated As most operating macroeconomic models deal with developed countries, these Project LINK countries represent a reasonable sample

Table 1—Relative importance of agriculture to the economy, by country, 1960-75

Country	CONS		PROD		IMPORTS		EXPORTS	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
	Percent							
Australia	29 7	3 0	8 9	2 2	9 0	3 9	64 1	13 3
Austria	38 1	3 6	7 9	2 0	16 0	5 6	9 9	6 3
Belgium	31 7	2 3	4 7	1 2	17 3	3 1	10 0	6
Canada	23 4	1 3	4 7	8	12 8	4 7	22 5	12 5
Finland	40 2	2 1	14 0	2 5	14 4	5 3	5 6	6
France	33 1	6 4	7 1	1 2	24 6	9 3	19 2	1 9
Italy	43 5	4 0	10 6	2 0	29 3	6 1	12 5	3 9
Japan	36 4	3 3	8 8	2 7	31 2	9 7	4 7	4 5
Netherlands	28 4	2 9	6 8	1 0	17 8	1 7	27 6	2 8
Sweden	29 4	9	5 1	1 0	12 7	2 8	3 9	7
United Kingdom	34 1	2 3	2 9	4	32 7	9 2	8 0	8
United States	19 3	1 6	3 3	5	22 8	9 8	22 4	7 0
West Germany	31 9	3 4	3 9	9	25 8	5 6	3 6	7

Sources (*9*, *12*)

In table 1, CONS represents the private final consumption expenditures on food, beverages, and tobacco at current prices as a percentage of private final consumption expenditures at current prices PROD represents the domestic product of agriculture, hunting, forestry, and fishing industries at current prices as a percentage of gross domestic product in purchasers' value at current prices IMPORTS represents total agricultural product imports as a percentage of total merchandise imports EXPORTS represents total agricultural product exports as a percentage of total merchandise exports Table 1 presents the mean and standard deviation of the annual measures of agriculture's relative performance

Consumption of agricultural products accounts for 20-40 percent of total consumption For several countries, agricultural trade represents over 20 percent of total trade Agriculture tends not to be as important a part of production in developed countries as in developing countries, however, the importance of agriculture is relatively high in the consumption or trade categories of developed countries Any sector that consistently contributes over 20 percent of the total—be it production, consumption, or trade—probably warrants separate attention in any modeling effort that attempts to provide sectoral disaggregation Thus, all the countries listed in table 1 could benefit from including an agricultural sector in their macroeconomic models

The Agricultural Specification of Macroeconomic Models

In this section, I survey several operational macroeconomic models I review the equation specifications to determine what agricultural sector variables (endogenous or exogenous) were included in the models and how the agricultural sectors were specified Only recently could a researcher conduct such a survey The survey's success hinges on two events (1) widespread acceptance of the models and (2) adequate documentation

Although macroeconomic models have existed for many years, only recently have they moved from the position of academic exercises to that of acceptance as relevant fore casting and policy tools which are regularly used Even after macroeconomic models were accepted and used, many remained solely aggregate national account models Only recently have some of these models been expanded to the point that they actually contain sectoral details which are endogenously determined [2]

Many of these models were developed or were improved by commercial econometric modeling firms These firms have a vested interest in keeping their model specifications a "black box," at least for anyone who is not a customer This phenomenon, coupled with the general problem of the extremely low priority of detailed documentation for "others," has made this type of equation-by-equation review very difficult—until recently

The publication of *The Models of Project LINK* (*20*) has made available the detailed model specifications for a series of macroeconomic models Not only is the LINK model an operating world model, but each country model in LINK is also an autonomous operating model in the country it represents These LINK models can give us some idea how macroeconomic models in different countries have treated agriculture Wherever other models were available, I have also reviewed them

Project LINK

Project LINK is a cooperative, international study group that manages the development and operation of a world macroeconomic model The Project LINK world model consists of a set of individual country macroeconomic models linked together through a world trade market-share matrix For each country model, it is assumed that export volumes and import prices are exogenous and that import volumes and export prices are endogenous The world trade market-share model component, through the world trade identities, determines that export volumes and import prices required for the solution of the individual country models Thus, through the world trade market-share component, the Project LINK model becomes one large simultaneous world model (*1, 16, 20*)

Table 2 summarizes the Project LINK macroeconomic models as they existed in the fall of 1973 (*20*) The appendix summarizes the specific structural specifications of the individual country models in the Project LINK model system

Most of the smaller Project LINK country models contain no agricultural variables—Belgium, the Netherlands, Developing America, Developing South and East Asia, Developing Middle East plus Libya, and Developing Africa minus Libya France has only one exogenous agricultural variable

Five of the country models—Australia, Austria, Canada, Japan, and the United Kingdom—contain endogenous agricultural variables that become components of aggregate national account variables, such as gross national product (GNP) and/or total trade In none of these five cases is there any feedback from the national account variables to the agricultural components The specification is strictly a recursive one

The Australian model determines gross national farm product, which becomes one component of GNP The Aus-

[2]For an excellent description of the genealogy of macroeconomic model development in the United States, see (*10*)

Table 2—Comparison of agricultural with total variables in the Project LINK modeling system

Country	Total model					Agricultural component				
	A priori and definitional equations	Stochastic equations	Total equations or endogenous variables	Exogenous variables	Total variables	A priori and definitional equations	Stochastic equations	Total equations or endogenous variables	Exogenous variables	Total variables
	Number									
Australia	41	42	83	78	161	1	0	1	6	7
Austria	83	54	128	42	170	0	2	2	3	5
By count[1]	83	45	128	47	175	—	—	—	—	—
Belgium	6	19	25	20	45	0	0	0	0	0
Canada	139	44	183	126	309	8	0	11	15	46
By count[1]	169	45	214	146	350	—	—	—	—	—
Finland	84	60	144	67	211	8	13	21	7	28
France	13	19	32	29	61	0	0	0	1	1
West Germany	87	51	137	11	148	0	3	3	1	4
By count[1]	77	50	127	22	137	—	—	—	—	—
Italy	51	53	104	60	164	0	1	1	3	4
Japan	35	43	78	41	119	1	3	4	2	6
Netherlands	74	13	87	64	151	0	0	0	0	0
Sweden	58	75	133	97	230	0	5	5	2	7
United Kingdom	120	106	226	135	361	0	3	3	2	5
United States	137	70	207	121	328	4	1	5	8	13
Developing America	1	11	12	6	18	0	0	0	0	0
Developing South and East Asia	1	13	14	6	20	0	0	0	0	0
Developing Middle East plus Libya	1	9	10	5	15	0	0	0	0	0
Developing Africa minus Libya	1	10	11	6	17	0	0	0	0	0
Project LINK system	932	691	1,613	914	2,528	22	31	56	50	106
By count[1]	952	683	1,635	950	2,571	—	—	—	—	—

— = Not applicable

[1]The summary of the Austrian, Canadian, and West German models in (20) gives a different number of equations and variables than are observed from a detailed review of the variables and equation lists Both sets of numbers are reported in this table The agricultural component count for Canada also shows an inconsistency Three endogenous and four exogenous variables defined in the variables list do not appear in any of the reported equations

trian model endogenously determines agricultural import quantities and export prices, which in turn help determine the value of agricultural imports and exports These then become components of total imports and exports Canada has the second largest agricultural block in Project LINK with 26 variables However, most equations are definitional and are used to determine agricultural investment and agricultural labor income, which become components of GNP Canadian exogenous wheat exports become one component of total exports The Japanese model determines agricultural investment, which becomes a component of total investments, which in turn is used to estimate GNP GNP is used to determine total consumption, which helps determine food and feed imports Food and feed imports then become one component of total Japanese imports In the U K model, an agricultural contribution to tax receipts is estimated and aggregated with others to obtain total tax receipts Tax receipts then become part of GNP Agricutural imports also become one component of total imports

In two of the above countries, Canada and Japan, additional agricultural variables are functions of aggregate income variables These are component disaggregations The specification is still a recursive one The only difference is that these equations must be solved after the simultaneous solution of the national account variables rather than before, that is, they are post-simultaneous equations rather than pre simultaneous equations

Five of the country models—Finland, Italy, Sweden, the United States, and West Germany—have agricultural variables that are integral parts of the simultaneous equation blocks that determine the aggregate national account variables In these five country models, feedbacks exist between agricultural and nonagricultural variables

In the U S , West German, and Italian models, this feedback mechanism works through the trade sector Food imports represent one component of total imports, which helps to determine aggregate income, which in turn helps directly or indirectly to determine food imports The U S model has a second feedback loop operating through the farm inventory investment/total investment/GNP/inventory deflator/farm inventory investment cycle The Finnish model's feedback mechanism works through a wages and salaries block Wages help determine income, which determines total consumption, investment, and trade, which determines agricultural production and, therefore, agricultural labor input requirements These in turn determine agricultural wages, which become one component of wages and salaries to complete the feedback loop The Swedish model builds the agricultural sector/national account feedback loop from the production side Total production helps determine disposable income, which helps determine food consumption, which helps determine food production, which in turn is part of total production

Although the U K model as a separate model has no feedback loops between agricultural and national account blocks, the situation changes when it becomes a part of the Project LINK world model In the Project LINK system, a feedback loop exists One determinant of agricultural import prices is U K exports Agricultural import prices help determine food imports and, therefore, total imports and GNP in the United Kingdom Through the Project LINK trade mechanism, the U K 's GNP affects world trade patterns and, therefore, U K exports

A similar situation exists for Austria and Japan When these two models become a part of the Project LINK system, a feedback loop is created The loop in these countries is through world trade variables affecting domestic income and, therefore, consumption, which helps determine these countries' agricultural imports, which are a component of these countries' total imports

Even when the agricultural variable levels are simultaneously determined with the other variables, the specifications of the agricultural sectors can be characterized as fragmentary Not enough of the agricultural sectors are specified to provide a reasonable view of agricultural behavior

Chase International Model

The Chase Econometric Associates, Inc (CEAI) international model (*3, 4, 5, 18*) consists of linked macroeconomic models for Canada, Japan, the United Kingdom, the United States, Germany, France, Italy, Belgium, the Netherlands, Spain, Mexico, and Brazil All these models are small, aggregate national account models with no sectoral detail An outline of the Brazilian model shows exports by industry with traditional fish and agricultural products separated into coffee, soya, and other products However, the equation book and forecast model manual I saw showed no disaggregation of Brazil's exports Recent forecast reports do show separate agricultural and trade forecasts for both Brazil and Mexico, but they do not indicate whether these variables are endogenous or exogenous

Economic Models International Models

The Economic Models, Ltd , international models (*7, 8*) are also relatively small, aggregate, national account, macroeconomic models that contain no agricultural variables Countries modeled include Belgium, France, Germany, Italy, the Netherlands, the United Kingdom, Japan, and the United States This company was recently sold to Data Resources, Inc Data Resources announced that these models would serve as the basis for the expanded Data Resources, Inc , international forecasting service

DRI International Models

I have not seen the detailed specifications of the Data Resources, Inc (DRI) international models, however, I understand they are also small, aggregate, national account models without agricultural variables

Evans Economics International Models

The Evans Economics, Inc, international models are also relatively small, aggregate, national account, macroeconomic models Countries modeled include Australia, Belgium, Canada, France, Italy, Japan, the Netherlands, Switzerland, the United Kingdom, and West Germany Only the Canadian model contains any agricultural variables—farm income and a producer price index for agriculture Both are exogenous (*6*)

WEFA International Models

The Wharton Econometric Forecasting Associates, Inc (WEFA) international models are relatively small, annual, aggregate, national account, macroeconomic models (*21*) Although I have not seen the equation books, I understand that all the national model specifications are similar The closest thing to an agricultural variable seems to be the forecasts for exports and imports of primary goods A prospectus indicates that models are operational for Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, the USSR, Yugoslavia, Argentina, Brazil, Canada, the United States, Iran, Saudi Arabia, South Africa, Turkey, Australia, China, Japan, Korea, New Zealand, Taiwan, the Developing Countries, and the Centrally Planned Economies WEFA staff say that they plan to disaggregate the Developing Countries region into several medium-sized macroeconomic models soon They indicate that these models will be supply-oriented models and will include both agricultural and nonagricultural production functions WEFA indicates that a major goal is to keep the models relatively small Therefore, they have no plans to incorporate agricultural sector detail into these models

Macroeconomic Models of the United States

Three of the major macroeconomic models of the U S economy are those developed by CEAI, DRI, and WEFA The Mark III version of the WEFA model has already been reviewed as the Project LINK U S model One evaluation of the models concluded that " the WEFA model is the only one with a definable agricultural sector In CEAI, the agricultural sector is subsumed in the 'all other industries' categories while in DRI, the only agricultural variable endogenously determined is proprietors' income, estimated as a reduced form equation of producer level prices received and paid by farmers" (*13*, p 2)

Roop describes the WEFA model's agricultural sector in the following manner

> Since the Wharton model has an agricultural sector, the linkages to the remainder of the economy are fairly well developed Output originating from the agricultural sector gets combined with outputs from other sectors to generate total supply—which is then reconciled with GNP calculated from the demand side Similarly, the wage bill, proprietors' income, and investment in the agricultural sector are added to those items from other sectors to produce total wages, total investment and total proprietors' income (*14*, p 14)

Roop and Zeitner provide an equation-by-equation summary of the specification of the Wharton Mark IV agricultural sector

> Five behavioral equations in Mark IV describe economic activity within the agricultural sector Fixed nonresidential agricultural investment (IAAG) is determined by the ratio of the implicit price deflator for agricultural output to the user cost of capital, a distributed lag of past output, and lagged value of the estimated error (Cochrane-Orcutt technique) Output originating in agriculture (XAG) is determined by only one explantory variable, personal consumption expenditure for non-durable food and beverages The implicit deflator associated with XAG (PXAG) is determined by prices received and prices paid, both taken as exogenous Compensation per man-year (WRCAG$) is determined by distributed lags of three explanatory variables, the potential unemployment rate (CVWNRUT), the consumer price index (PC*), and the ratio of output to agricultural employment (XAG/NEHA) The ratio of proprietary farm income (YENTF$) to the current value of agricultural output is explained by the ratio of prices received to prices paid (PFR* and PFPC*, both exogenous variables)
>
> The linkages of the implied agricultural sector with the rest of the economy are both direct and indirect Farm investment and the change in farm inventories (IBIF, considered exogenous) in real terms are elements of aggregate investment demand, a component of real gross national product (GNP) Output originating in agriculture is added to other industry outputs and reconciled with the GNP After prices are computed, including the implicit deflator for agricultural output, the current value of GNP is determined National income, including proprietary farm income, is calculated by an identity relation that includes

the wage bill in agriculture Farm prices received enter directly into the determination of the unit value index of food exports (PTEEGDF) and the change in the wholesale price index of crude materials (PWPC*) In an indirect fashion, the implicit sector deflator (PXAG) enters into the determination of most other implicit deflators All the implicit deflators for the components of aggregate demand are estimated as a ratio to weighted averages of the industrial sector implicit deflators, the weights having been derived from a separate input-output study Thus, a current quarter increase in PXAG will enter into the determination of most other prices in the same quarter (*15*, p 117-18)

Each of these three firms has also constructed separate, agricultural sector models that contain considerable commodity detail These firms contend that agriculture can be more adequately handled via these separate modeling efforts They say that although the models are separate, the models could be solved in an iterative fashion with forecast values passed from one model to the other until a consistent forecast is obtained from both models Although this approach would work in theory, I suspect these firms seldom, if ever, operate their models in this manner In fact, given the specifications Roop reported, there are so few agricultural linkage points in the macroeconomic models that, even with this iterative procedure, little feedback is possible

Conclusions

Agriculture is an important sector of the national econ omy The general trend in macroeconomic modeling tends to be toward increasingly detailed models, and agriculture is a logical area of interest

The agricultural sector is generally ignored or is treated exogenously by model builders When the sector is treated endogenously, the specification is far from satisfactory from the viewpoint of an agricultural economist Agricultural economists would criticize most endogenous agricul tural sectors as being structurally misspecified and/or as too small to provide relevant information about agricul ture to agriculturalists Because of this, simulation results from agriculture/nonagriculture policy shocks have little credibility, particularly with agricultural economists

Agricultural economists look at agricultural issues Perhaps this has caused general economists to overlook the agricultural block when incorporating sectoral detail into their models Economists may have assumed that, as agricultural economists were modeling the agricultural sector in detail, they could treat agriculture as exogenous However, as Subotnik (*19*) indicates, agricultural economists are not incorporating this area of agriculture/nonagriculture linkages into their operational models either

Work in this area will soon run into methodological problems Macroeconomic models have been built with macroeconomic methods, whereas agricultural commodity models have been built with microeconomic methods Macroeconomics starts from the viewpoint of aggregate economic behavior and attempts to model this aggregate behavior directly Microeconomics starts from the viewpoint of the individual and attempts to explain why individuals behave the way they do Market phenomena are explained by an aggregation of individual behavior In one case, aggregate agricultural sector behavior is arrived at through a thought process involving aggregation In the other case, it is arrived at through a disaggregation process As they start from different world views, these two processes may not reach the same, or even compatible, positions Incorporating agriculture into macroeconomic models may involve using macroeconomic methods in the construction of the agricultural component This may require focusing less on supply/demand type commodity models and more on aggregate farm account, production process, and agricultural consumption function models that can be integrated into the existing macroeconomic models more directly In fact, the existing, detailed, microeconomic, supply demand agricultural commodity models may be more easily linked to macroeconomic agricultural components than to the existing, national account, macroeconomic models Conceivably, the proper approach to developing feedback loops between agriculture and the rest of the economy may best be achieved indirectly Instead of directly linking macroeconomic models to commodity models, it would be preferable to link the models indirectly—that is, from macroeconomic to macroeconomic agriculture to commodity models This may prove the most fruitful approach to modeling this agriculture/nonagriculture interface

No matter how this question is finally resolved, the first prerequisite is for people to work on the problem The economics profession (both general and agricultural) does not yet have even that Given the increased interest in, and the importance of, agriculture, I should think the return on work in this area would be quite high

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Appendix: A Summary of Project LINK Country Model Agricultural Sectors

Australia

There are seven agricultural variables in the Australian model Only one is endogenous, and it is a product of two exogenous agricultural variables (when gross national farm product is defined as gross national farm product at 1966 prices times the price deflator for gross farm national product)[3] This model is generally defined in terms of national account variables by major sectors The exogenous agricultural variables defined here provide one component of a sum used to calculate aggregate national account variables

Austria

There are five agricultural variables in the Austrian model All are included in the trade sector only Two are endogenous—imports of SITC 0 + 1 goods and SITC 0 + 1 export price index Imports of SITC 0 + 1 goods are specified as a function of private consumption of nondurables, GNP of the agricultural sector, and lagged imports of SITC 0 + 1 The SITC 0 + 1 export price index is a function of time, the total demand price deflator, and the lagged SITC 0 + 1 export price index relative to the total demand price deflator These two endogenous variables are then combined with the exogenous SITC 0 + 1 import price index and the exports of SITC 0 + 1 goods to define one component of total imports and exports

Belgium

No agricultural variables are included in the Belgian model

Canada

There are 26 agricultural variables, 11 of which are endogenous, in the Canadian model These include variables dealing with agriculture, fishing, and/or trapping Of those defined in the variables list, four endogenous variables and four exogenous variables are not listed in the model equations All endogenous agricultural variables are definitional in nature[4] The agricultural variables are concentrated in the foreign trade, investment/capital stock, employment, and production blocks The latter three blocks feed the income block

[3]This definitional equation and variable are not listed in the equation or in the variable list, however, the variable is used in another definitional equation

[4]Of the four unexplained endogenous variables, three are definitional Employment in agriculture, fishing, and trapping is undefined

Two exogenous agricultural variables in the foreign trade block—wheat export quantities and wheat price—deter mine the value of wheat exports Wheat exports then become one component of total merchandise exports

The investment/capital stock block includes several exogenous agricultural investment components that are used as components in calculating GNP These investment variables, along with initial capital stock levels, are used to generate future capital stock levels and thereby the capital/output and capital/labor ratios for agriculture

The employment block variables consist of exogenous agricultural wage rates and endogenous employment that determine labor income in agriculture, which becomes one component of total labor income

The production block consists of exogenous estimates of real gross domestic agricultural product and the implicit gross domestic product (GDP) price index for agriculture which are used to calculate agricultural output, which in turn affects corporate profits and ultimately components of national income (net national income itself is based on adjusted GNP)

Thus, agriculture in the Canadian model is essentially exogenous and is used to provide components of aggregate variables, whereas the other sector components are endogenous There is no feedback from the nonagricultural sec tors to the agricultural sector in this model

Finland

The production, employment, price, and income components of the Finnish model have been disaggregated into agriculture, noncompetitive industries, forestry, and competitive industries sectors Of the 28 agriculturally oriented variables in the model, 18 (6 are exogenous) are in the agricultural sector and 10 (1 is exogenous) are in the forestry sector

The production-employment-price-income component of the agricultural and forestry sectors are similarly defined Each sector component is essentially driven by three variables—sector input prices, sector prices, and sector production Sector prices are exogenous whereas sector input prices are a function of raw material prices, fuel and lubricant prices, and time Sector production is a function of total consumption, total investment, total exports, total imports, inventory change, and time These variables determine sector production at factor cost and then nonwage income for the sector Prices and production in the sector also generate labor inputs and wage rates in the sector These in turn yield sector wages and salaries and sector social security payments Each of these measures in turn becomes a component of total wages and salaries, total social security payments, total disposable income, and GNP

France

The French model contains one exogenous agriculture variable—employment in agriculture The percentage change in total employment is partly a function of the percentage change in agricultural employment

Italy

There are four agricultural variables in the Italian model Only the value of agricultural imports is endogenous Agricultural imports are a function of the three exogenous variables—the gross agricultural product, the wholesale price index of agricultural products, and the unit value index of agricultural imports—plus private consumption, the exchange rate, and quarterly dummies Agricultural imports then become one component of total imports The unit value index of agricultural imports becomes one component of the import price index The wholesale price index of agricultural products and gross agricultural product, respectively, are used to derive a general index of consumer prices and gross product in the services sector

Japan

The Japanese model contains six agricultural variables Two are exogenous—real agricultural inventory investment and the implicit price deflator for agricultural inven tory investment These variables are used to determine total investment, and then GNP, national income, and consumption Consumption, in turn, determines real food and feed imports, which then become a component of total imports Employment, wages, and wages in agriculture determine self-employment in agriculture, and then unemployment as a residual The product of agricultural wages and self-employment in agriculture also determine agricultural income Self-employed nonagricultural income is calculated as a residual The agricultural variables are used to provide disaggregated component forecasts, but they do not provide feedback for determining the aggregate national account variables

Netherlands

There are no agricultural variables in the model for the Netherlands

Sweden

The Swedish model contains five endogenous and two exogenous agricultural variables [5] The model's agricultural

[5]The Swedish model contains an additional 12 endogenous and 4 exogenous variables in the wood and pulp, paper, and paper board industries

block centers on the forecast of food consumption Food consumption in turn is used to forecast food production, food imports, and the SITC 2-4 category imports Food consumption also provides one component of total private consumption and, therefore, GNP Food production then determines sales of industrial products and raw material food inventories, and it provides one component of total mining and manufacturing production Total inventory stocks are determined partly by total mining and manufac turing production, raw material food inventories, and finished-goods food inventories (which are a function of total private consumption) Total mining and manufactur ing production affects disposable income, which in turn affects food consumption The two exogenous variables, controlled agricultural prices and agricultural inputs to the chemical industry, respectively, help determine that industry's disposable income and its sales of industrial production

United Kingdom

There are three endogenous and two exogenous agricultural variables in the U K model Agriculture enters the model in two areas First, the consumption of nondurable goods and the discretionary change in beer, wine, spirits, and tobacco duties determine the level of duties on beer, wine, spirits, and tobacco These in turn provide one component of tax receipts Second, the exchange rate, world export prices, and world exports of manufactures determine the unit value index for imports of food, drink, and tobacco This price variable (deflated), time, two strike dummy variables, and a food import fluctuations dummy variable are used to calculate the level of imports of food, drink, and tobacco This import variable and the import unit value index in turn become components of total imports (both quantity and value)

United States

There are eight exogenous and five endogenous agricultural variables in the U S model Most of the agricultural detail in this model is in the investment sector Real farm business inventory investment is defined as the change in the exogenous farm inventory stock This becomes a component of total real inventory investment and—along with the exogenous implicit deflator for gross product originating in agriculture, forestry, and fish—defines current-dollar farm business inventory investment and then total current-dollar inventory investment Real investment in farm structures is exogenous Along with the implicit deflator for fixed investment in farm residential struc tures, it determines nominal farm residential structures investment and then total residential investment The two investment figures in turn help determine GNP GNP and the exogenous gross product originating in agriculture, forestry, and fisheries define gross product originating in commercial and other industries This variable then helps determine the nonfarm, residential structures, investment deflator The ratio of the farm, residential structures, investment deflator to the nonfarm, residential structures investment deflator in period t is the same as in $t-1$, thus making the farm deflator a function of the nonfarm deflator

The exogenous agriculture, forestry, and fisheries employee compensation is one component of total employee compensation This, along with GNP, helps determine corporate profits

Food imports are a function of disposable income, a dock strike dummy variable, and three exogenous agricultural variables—the food import price, the consumer food price index, and a Brazilian coffee crop failure dummy variable Food imports and food import prices then become one component of both real and nominal total imports, which in turn helps determine GNP

The agricultural sector of the U S model can, therefore, be seen as essentially exogenous to the overall model structure

West Germany

There are four agricultural variables, three of which are endogenous, in the West German model All are in the trade sector Retail food prices determine the quantity of agricultural imports, which in turn becomes one component of total import quantities These import quantities, combined with the exogenous agricultural import price; determine the value of agricultural and, therefore, total, imports

Developing America

There are no agricultural variables in the Developing America regional model

Developing South and East Asia

There are no agricultural variables in the Developing South and East Asia regional model

Developing Middle East plus Libya

There are no agricultural variables in the Developing Middle East plus Libya regional model

Developing Africa less Libya

There are no agricultural variables in the Developing Africa less Libya regional model