An Adaptive Policy Simulation Model to Analyze Price Reforms for Lithuanian Food and Agricultural Products

Natalia Kazlauskiene,
S. Devadoss, and William H. Meyers

June 1991
Report 91-BR 1
(Formerly CARD Technical Report 91-TR 20)

Lithuanian Institute of Agrarian Economics
Vilnius, Lithuania

Center for Agricultural and Rural Development
Iowa State University
Ames, Iowa 50011

Natalia Kazlauskiene is lead scientist and head of the Research Group, Lithuanian Institute of Agrarian Economics. S. Devadoss is an assistant professor of agricultural sciences at Tuskegee University and a former CARD research associate. William H. Meyers is professor of economics and associate director of CARD.

The Lithuanian Institute of Agrarian Economics, Vilnius, and CARD, Iowa State University, are collaborating on a number of research projects related to all facets of economic reforms in Lithuania. This paper is a result of that joint venture.

CONTENTS

FIGURES

TABLES

AN ADAPTIVE POLICY SIMULATION MODEL TO ANALYZE PRICE REFORMS FOR LITHUANIAN FOOD AND AGRICULTURAL PRODUCTS

Lithuania is one of the three Baltic republics. Its area is 25.2 thousand square miles and it had a 1989 total population of 3.72 million people. The republic is currently moving towards independence. There are numerous political changes as a result of this move towards independence. One outcome of these political changes is the reform of existing economic policies that have been governed by highly centralized planning systems since the incorporation of the republic into the Soviet Union in 1940. All sectors of the economy will be affected by these economic policy changes. Economists, government legislators, and leaders of agricultural and industrial enterprises were heavily involved in the process of formulating economic reforms. The final goal of the reforms is to move towards a market-oriented economy. Within this framework of overall reform, the agricultural sector has been emphasized because of its nature and its importance to the national economy. Traditionally, the republic has been agriculturally oriented. For instance, the contribution of the agro-industry to the total GNP of the republic was 50.4 percent in 1989, compared with 42.6 percent in 1980 and 50.3 percent in 1975. The rural population, heavily employed in the agricultural sector, comprises 31.5 percent of the republic's total population.

The agro-industry consists of three sectors: input production and supply for agriculture, production of primary agricultural products, and processing of agricultural products. Among these three sectors agricultural production is the largest. For example, in 1989 this sector's contribution to the agro-industry GNP was 48.4 percent, it employed 56.0 percent of the labor force, and possessed 70.1 percent of the agro-industry's assets.

The recently implemented policy reforms and others still under discussion are intended to alleviate the economic problems in the current production and distribution systems. First, the current

system of large-scale farming based on state ownership of land and a salaried labor force does not provide incentives for the farmers to produce more efficiently. Also, under the current farming system, the state has the monopoly in marketing agricultural products, in supplying inputs and agro-services, and formulating policies related to pricing, taxation, and banking and credit supply. This monopoly control of agriculture leads to an inefficient economic system. Second, agricultural production depends heavily on imported inputs such as machinery, fertilizers, pesticides, and feed grains from other republics or from other countries through the all-union fund. Because of this dependence on imports, particularly grains, the livestock production mix has to be examined relative to the availability of feed-grain imports. Third, agricultural production has been highly subsidized by the state treasury. State procurement prices for agricultural products have been higher than retail prices, and the processing sector has also been highly subsidized. Fourth, major trade flows of agricultural inputs and outputs are with other republics of the Soviet Union or the all-union fund because of the lack of hard currencies in the republic. Moreover, since the domestic currency cannot be converted in foreign markets, trade with foreign countries is limited.

The proposed policy reforms cover all spheres of the agro-industry. Some of them deal with fundamental changes in the structure of the farming system, ownership of the land and other resources, and management of the farms. Others deal with economic considerations such as price policies, income subsidies, processing industries, tax policies, development of banking and credit systems, and establishment of cooperatives for marketing, input supply, and agro-services. The reforms also include changes in state procurement policies for agricultural outputs. Specifically, these reforms would lead to the emergence of alternative marketing systems, including a market-oriented system for agricultural products. One of the reform goals is to reduce the dependency on imported inputs and move toward self-sufficiency in commodities such as feed grains. While this goal seems inconsistent with the development of a market economy, it may be a practical necessity in the short

run, due to the lack of hard currency markets for agricultural product surplus and the uncertainty of trade arrangements with other republics.

Formulation of policies for these reforms at the national level requires proper understanding of current economic problems, the nature of the economy and the agricultural sector, and also knowledge of the market economy system. Furthermore, there is a greater need for undertaking economic research that will provide analytical information for short-term and long-term economic policy decisions. One of the prerequisites of such analysis is to provide an economic evaluation of the supply and demand components of various markets. However, such studies have not yet been undertaken for Lithuania at the macro level.

Policy Impacts and Study Objectives

This study develops a supply and demand model to provide economic information that can be used to make policy decisions. The model evaluates the potential impacts of dramatic price reforms for farm products in 1990 and for consumer products in 1991. The analysis provides results that will be useful in guiding policy decisions and more detailed policy research.

In this current transition period toward a market-oriented economy, the Lithuanian government will be undertaking various policy measures that will have significant impacts on all spheres of the economy, particularly the agro-industry. The purpose of this study is to develop a microcomputer-based model that can be used to evaluate a range of changes in agricultural policies, macroeconomic policies, and structural changes. This model provides a flexible and efficient policy analysis tool that can be used to test alternative specifications and parameters and to evaluate the sensitivity of impact analysis to varying assumptions. The results of the analyses, in addition to their value in policy formulation, can also provide information needed to develop other relevant economic models.

Modeling Approach

There are several modeling approaches for policy analysis. Some of the common approaches are based on a general equilibrium model, multicommodity supply and demand econometric models, or programming models. Each of these approaches has some advantages and disadvantages.

General equilibrium models are known for their completeness and theoretical precision, but they are generally large and complex and not well suited for short-term policy analysis. Consequently, these models are not appropriate for this study. Multicommodity econometric models provide the required level of commodity disaggregation, but it is difficult to estimate the demand and supply elasticities because of limited data availability. The programming models are relatively simpler to construct but they are somewhat rigid in their structure and do not provide all the detailed information necessary for policy analysis.

Because of the difficulties of applying these models to policy analysis, an adaptive policy simulation model (APSM) is used in this study. The APSM is designed as a simplified representation of the econometric multicommodity models. This model is a modification of an earlier one developed by Meyers and Devadoss (1987); it takes into account the specific features of the Lithuanian agro-industry and recent policy changes.

The APSM is relatively simple to construct and can be used readily to conduct sensitivity analysis of impacts related to different choices of parameters and model structure. This model, developed on a LOTUS spreadsheet program, can be used even if there is a data shortage that makes econometric modeling not feasible, or when time and cost constraints prevent the development of an econometric modeling system. It can be designed to closely replicate an econometric model but can also be easily used to test a range of specifications or behavioral parameters available from previous studies. Sensitivity testing is facilitated by the ease with which structure and parameters can be changed and computations can be completed. In addition to obtaining alternative results, using this

type of model for experimentation with structure and parameters provides a useful learning tool for policy analysts.

The major use of this type of model is in sensitivity and impact analyses. Sensitivity analyses could be conducted in generating a baseline by evaluating alternative underlying assumptions with respect to population growth, income growth, technological change, or price policies. Impact analyses from any given baseline are easily conducted by changing particular assumptions used in the base run.

Characteristics of Lithuanian Agriculture

Before presenting the structure of the model, it is important to understand how Lithuanian agriculture operates. Currently the farming system is based primarily on large-scale farming. These farms include both state and collective farms, which together comprise the state or public sector. The difference between these two types of farms lies in the ownership of assets and outputs. In both types of farming, land is owned by the government. In the case of collective farms, assets and outputs belong to members of the cooperatives. In the case of state farms, assets and outputs are owned by the government. Both types of farms are managed by a group of agricultural specialists whose duties are to supervise and provide consultation; however, they do not participate directly in production and cultivation practices. One of the problems of this management system is that there are too many supervisors. Consequently, production costs are increased significantly, since management expenses are included in the cost of production. Another problem is that agriculture is inundated with labor but has insufficient machinery and equipment, which causes low labor productivity.

In addition to the state sector, agricultural production is permitted on the personal plots of members of the state and collective farms. These plots are not owned by individuals but are available at no cost to the members. A certain amount of grassland, depending on the number of cattle on the personal plot, is also given to the members to be used for grazing. Therefore, the personal plots and

grasslands are free inputs in the production process. Traditionally, agricultural production in the personal plots is highly profitable because of the individual incentive to acquire more profits, to make efficient use of labor and other inputs, and the possibility to choose alternative marketing strategies. Production in the personal plots is not only profitable but also contributes significantly to total agricultural production. For example, in 1989 production from the personal plots contributed about 32.0 percent of total agricultural production. Of the total milk production in the republic, 38.7 percent came from cows raised on these personal plots. Before Lithuania was incorporated into the Soviet Union in 1940, its agricultural system was based purely on private family farming. Since current economic policy changes are intended to reestablish the private farming system, farming in the personal plots is a good basis for these changes.

Production in the livestock and crop sectors comprises total agricultural production. Livestock and crop production contributed 66 and 34 percent, respectively, of the total 1989 agricultural GDP. The major livestock products are beef, pork, chicken, eggs, and milk. Production on the personal plots contributes about 31 percent of total livestock products. Traditionally, more than 40 percent of livestock products are exported to other republics. At the same time, about 47 percent of the concentrated feed needed to produce pork and poultry is imported.

The major crop commodities are grains (wheat, rye, barley, oats), potatoes, sugar beets, flax, vegetables, and feed crops (feed roots, corn silage, grasses). Generally, about 78 percent of crop production is used for fodder and 45 percent of cultivable land is used to produce fodder. Only about 14 percent of total crop production is sold commercially, and the rest is used on the farm. Potatoes and vegetables are largely grown on personal plots, contributing more than 60 percent of total production of these commodities.

Crop production is greatly influenced by climate and weather conditions, a relatively short vegetative period, and soil quality. A large number and variety of crops are grown to accommodate these agronomic factors.

Most commercial production is sold through the state procurement system. The government formulates a pricing policy for the agricultural sector. Procurement prices as well as retail prices and processing subsidies are set by the government. Before the 1990-91 price reforms procurement prices were higher than retail prices because the government provided price supports to producers, price subsidies to consumers, and subsidies to processors. A small portion of agricultural production is sold in the free market where prices are determined by market forces. In the free market, prices are significantly higher than retail prices set by the government.

Conceptual Framework

The APSM is developed on a Lotus 1-2-3 spreadsheet, so changes in behavioral parameters and economic behavioral assumptions can be readily accommodated. Construction of the spreadsheet program allows the user to update data and extend the analysis period as needed. The specific features, structure, policies, and current reforms in Lithuanian agriculture were incorporated into the APSM.

It is assumed that producers have fixed inputs and, at the margin, allocate these inputs to alternative enterprises based on relative product prices. Consumers are assumed to allocate income to alternative goods, at the margin, based on relative prices of goods. So the present production and consumption structure provides the initial conditions, and this pattern of production and consumption changes through time primarily in response to price and income changes. If, for example, other research or observed data indicate that agrarian reforms cause a fundamental shift in production patterns, this can be accommodated easily by altering model parameters or initial conditions.

Prices are exogenous in this model, consistent with the reality that prices are either set by the government or by external markets. The initial assumption is that state prices dominate producer and consumer decisions. Even though there is significant production in private plots, much of this is sold through state and collective farms due to a lack of alternative marketing systems. Consumers also buy a portion of goods in the private markets where prices are higher; but this is still a very small share of basic food consumption, since quantity rationing has not been very severe in Lithuania. As more information becomes available on the portion of production and consumption being exchanged in the private market, prices in the supply and demand components can be computed as weighted averages of state and private markets.

The model has three basic components, as illustrated in Figure 1. The first component includes the exogenous assumptions defining the policies, technology, state of the economy, and behavioral parameters for supply and demand. The second component represents the food and feed commodity sector, including commodity supply, consumption, and trade. This component indicates how prices influence the distribution of production and consumption across commodities. The third component develops estimates of various performance measures. These performance measures are derived from the first two components and include growth and distribution of production and consumption, farm revenues, and government expenditures.

The structure of crop and livestock product modules in the second component is illustrated in Figures 2 and 3. The area harvested and yields are influenced by economic factors or by government policies. Domestic food consumption is influenced by prices, income, and the population. Domestic feed consumption is influenced by livestock production composition and growth. Domestic industrial use is constrained by the capacity of processing plants. In almost all cases, government policies determine or strongly influence farm and retail prices as well as input levels. Stock levels for most commodities are also determined by government policies. For feed commodities there is little

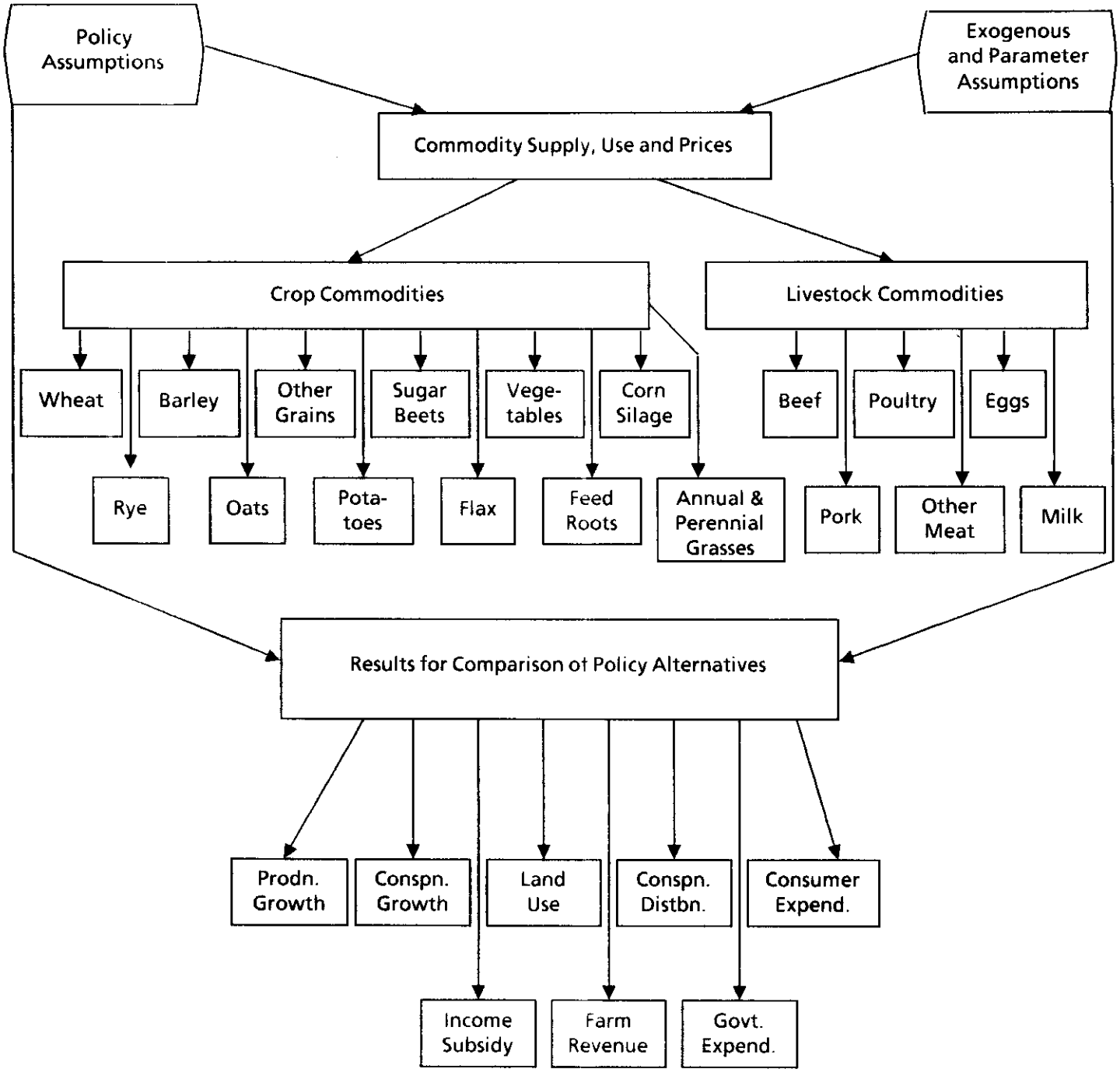

Figure 1. General components of the Lithuanian food policy model

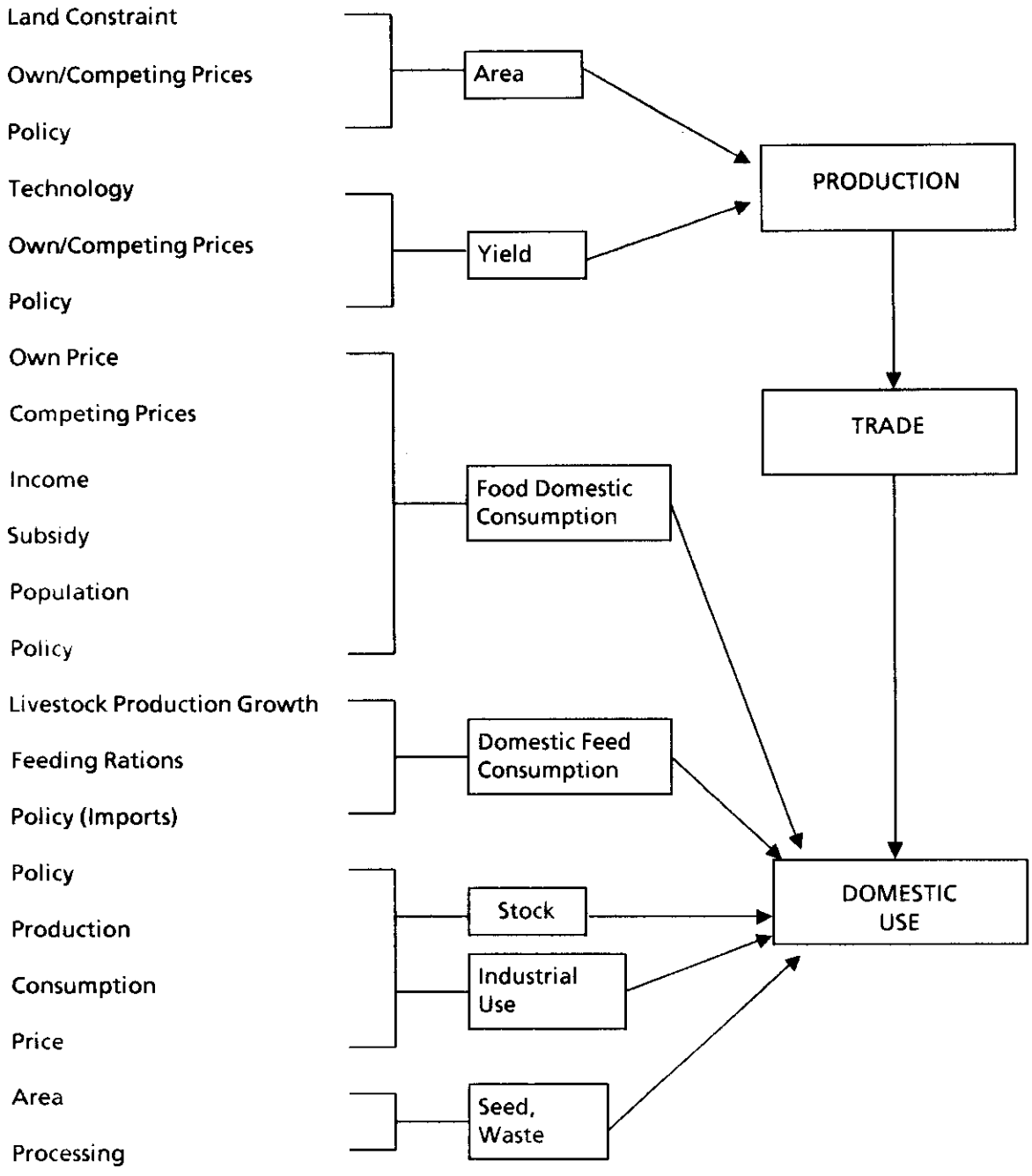

Figure 2. Components of crop commodity supply and use

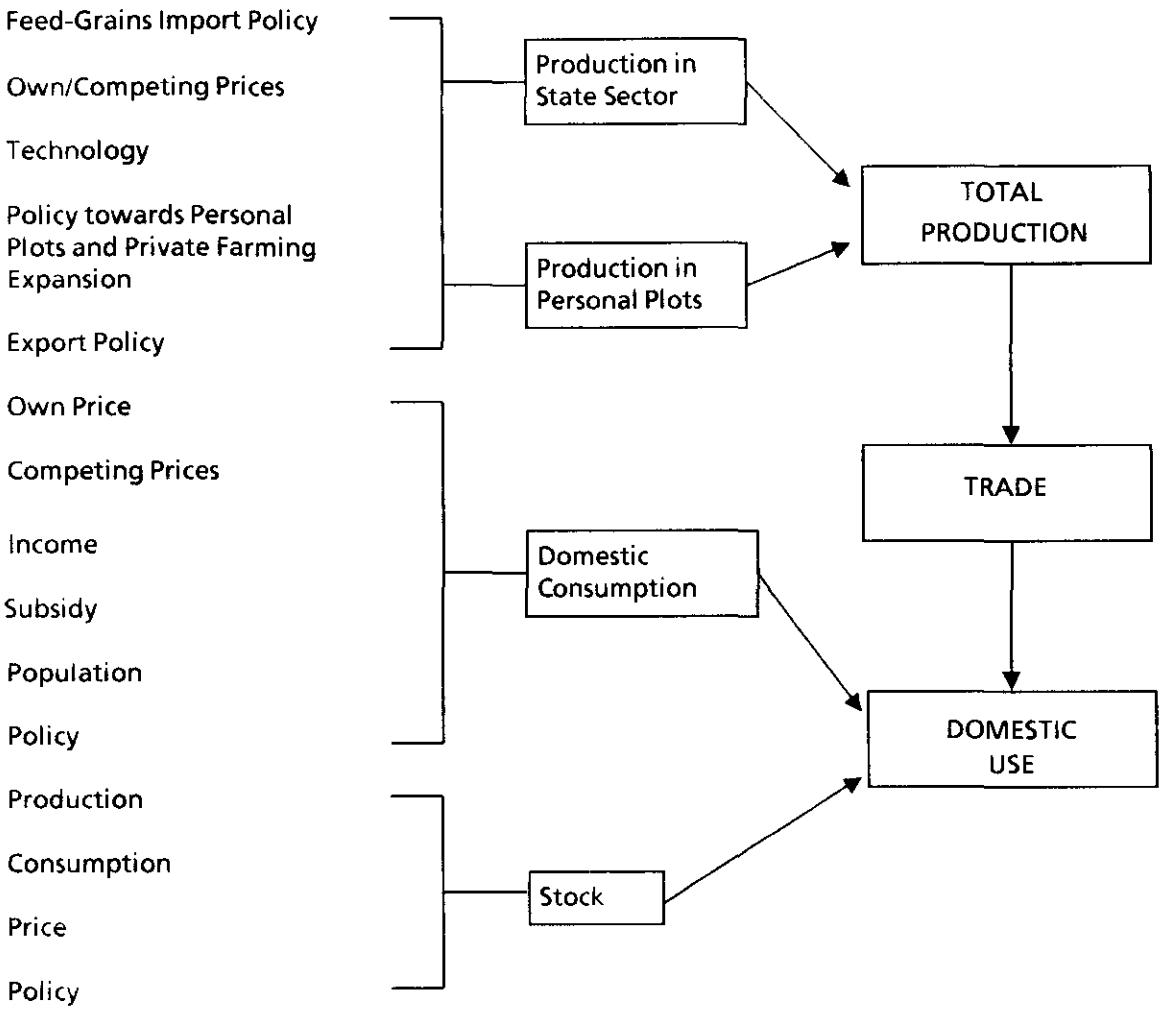

Figure 3. Components of livestock commodity supply and use

information about stock levels, so assumptions are made about changes in stocks based on historical data. Seed use and waste are set based on historic proportional relationships.

Important linkages between policies and performance measures are presented in Figure 4. The major policies to be evaluated are identified in the circles. These include policies on farm prices, retail prices, production costs, and stocks. Farm and retail price policies directly influence production and consumption. Through production, input levels and prices and farm prices affect farm income. Changes in retail prices and income influence food consumption. Since cross-price effects are also included, a change in one price can influence consumption and production levels for several food commodities. Domestic price policy and consumption levels also affect government expenditures through subsidies. Income subsidies affect consumption and government expenditures.

Hence, changes in only one policy will affect many of the macro- and microeconomic performance measures within the Lithuanian economy. A flowchart describing the structure and policy linkages of the model appears as Figure 5.

Commodity Supply and Demand

The core of the APSM is the commodity sector. The structure of the commodity supply and demand requires a set of own- and cross-price elasticities, which are presented in detail in the next section. The production and consumption relationships in the commodity sector are based on constant elasticity functions. A brief description of the model is provided, and is followed by more detailed algebraic equations and definitions.

Basic supply and consumer demand relationships start with previous year levels and projections are based on changing prices and income levels as appropriate. Supply equations have an exogenous nonprice growth factor that reflects technological change and government policy that may change the structure of production. Consumer demand includes population growth as an additional factor.

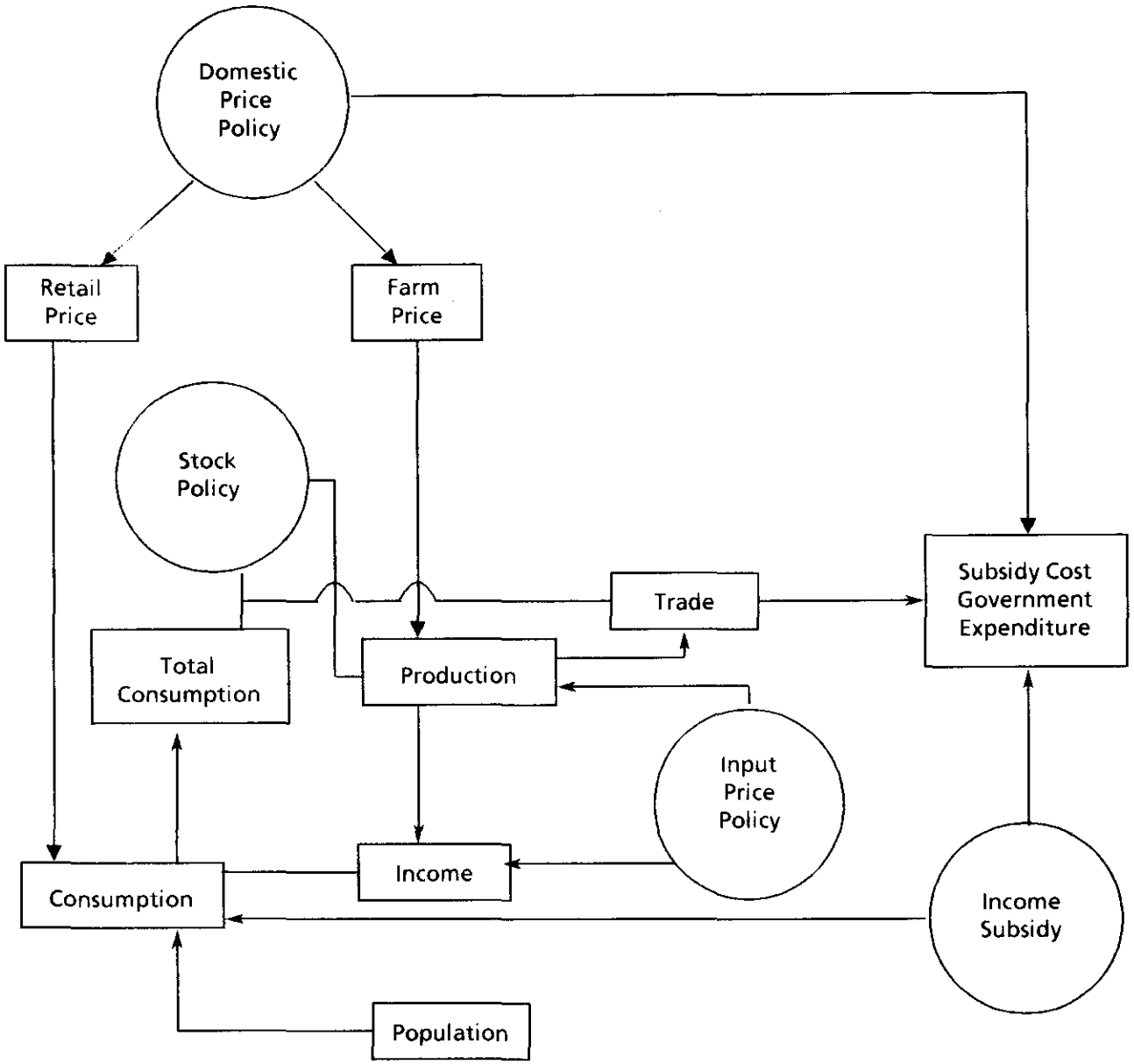

Figure 4. Linkages between policies and performance measures

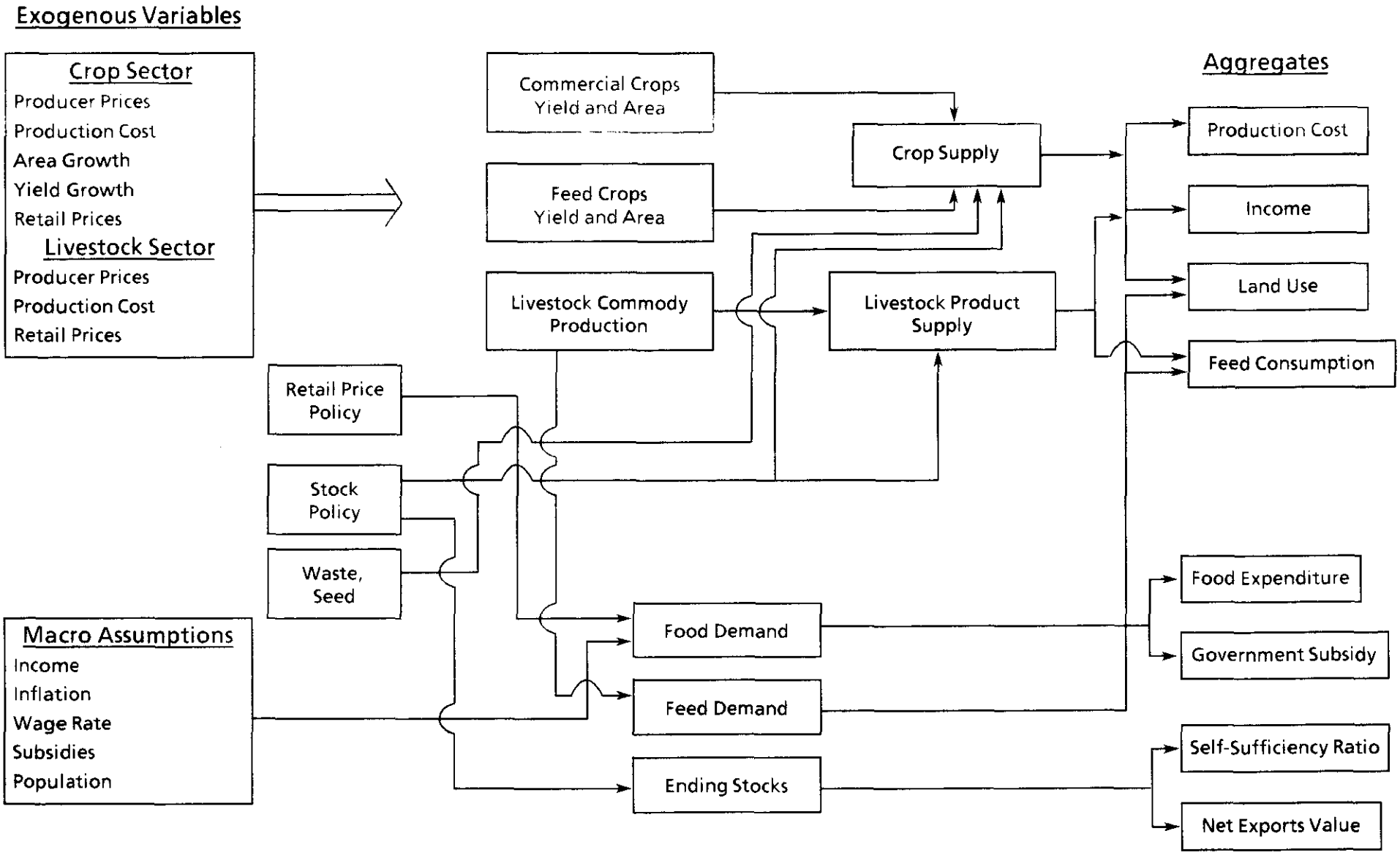

Figure 5. Structure of the national food commodity policy model for Lithuania

Crop Sector. Crops included in the model are wheat, rye, barley, oats, other grains, potatoes, sugar beets, flax, vegetables, feed roots, corn silage, and annual and perennial grasses. The crops are divided into commercial and feed crops. Production of these commodities depends on area harvested and average yield response. Area harvested and average yield are determined by exogenous area and yield growth rates, and own and cross prices (Eq. 1 and 2). Domestic supply is the sum of production and beginning stocks (Eq. 5). For most commercial commodities, exports and imports are determined by the government, so they are exogenous. In the model, however, crop trade is usually calculated as the difference between total demand and domestic supply, implying that the government will import what is needed and export what is surplus. The exception is potatoes, where exports are set at a level equal to the average of the last four years. Total supply is equal to domestic supply and imports (Eq. 7).

Per capita consumption is influenced by changes in retail prices and income (Eq. 8). Total food consumption is determined by multiplying population and per capita consumption (Eq. 9). Feed demand depends on the composition and growth rates of livestock production and the feed ration (Eq. 10). A detailed discussion of the determination of feed demand is provided in the next section. Industrial use of sugar beets and flax are determined by the capacity of the processing plants, which is specified as a proportion of production (Eq. 11). Stocks, seed, waste, and other uses are determined by a fixed proportion of production or consumption, depending on the crops (Eq. 12 and 13). For feed crops, ending stocks are computed as residual (Eq. 14). Domestic demand is the sum of total food demand, feed demand, industrial use, seed, waste, other use, and ending stocks (Eq. 15). For some commercial crops, net exports are calculated as the residual of demand minus supply (Eq. 16).

In addition to the supply and demand components, aggregate measures are also included for per capita consumption expenditures, self-sufficiency ratio, production cost, total farm revenue, and total area harvested (Eq. 17 through 22).

The derivation of the specifications for supply and demand relationships is from a log-linear function similar to:

$$Q_t = K P_t^e I_t^n.$$

Since K is unknown in the absence of empirical estimates, the following equivalent specification is used with the last year of actual data (1990) as the starting point:

$$\frac{Q_t}{Q_{t-1}} = \frac{Ip_t^e \; I_t^n}{K \; P_{t-1}^e \; I_{t-1}^n}$$

$$Q_t = Q_{t-1} \left(\frac{P_t}{P_{t-1}}\right)^e \left(\frac{I_t}{I_{t-1}}\right)^n$$

where Q_t is the variable of interest in period t, P_t is price in period t, I_t is income in period t, e is price elasticity, n income elasticity, and K is constant.

The crop model equations are formed as

$$A_{it} = A_{it-1}(1 + AG_{it}) * (FP_{it}/FP_{it-1})^{n_{ii}} * \prod_{J \in I_{c1}} (FP_{jt}/FP_{jt-1})^{n_{ij}}, \qquad i \neq j; \qquad (1)$$

Average yield

$$Y_{it} = Y_{it-1}(1 + YT_{it}) * (FP_{it}/FP_{it-1})^{m_{ii}} * \prod_{j \in I_{c1}} (FP_{jt}/FP_{jt-1})^{m_{ij}}, \qquad i \neq j; \qquad (2)$$

Production

$$QP_{it} = A_{it} * Y_{it}; \qquad (3)$$

Beginning stocks

$$QBS_{it} = QES_{it-1}; \qquad (4)$$

Domestic supply

$$QDS_{it} = QP_{it} + QBS_{it}; \qquad (5)$$

Imports (if $i \in I_{c1}$)

$$QM_{it} = K_{it}; \qquad (6)$$

Total supply

$$QTS_{it} = QDS_{it} + QM_{it} ; \tag{7}$$

Per capita consumption

$$QC_{it} = QC_{it-1} * (RP_{it}/RP_{it-1})^{e_{ii}} * \prod_{j \in I_{c1}} (RP_{jt}/RP_{jt-1})^{e_{ij}} * (I_t/I_{t-1})^{\eta_i}, \qquad i \neq j \tag{8}$$

Total food demand

$$QCT_{it} = QC_{it} * POP_t ; \tag{9}$$

Feed demand

$$QFD_{it} = [\sum_{j \in I_c} (QFD_{it-1} * FC_i) * (1 + LPG_t) * FR_{it}] / FC_i ; \tag{10}$$

Industrial use

$$QIU_{it} = QP_{it} * IUR_{it} ; \tag{11}$$

Seed, waste, and other use

$$QSW_{it} = QP_{it} * SWR_{it} ; \tag{12}$$

Ending stocks (if $i \in I_{c1}$)

$$QES_{it} = QP_{it} * SR_{it} ; \tag{13}$$

Ending stocks (if $i \in I_{c2}$)

$$QES_{it} = QTS_{it} - QFD_{it} - QSW_{it} ; \tag{14}$$

Domestic demand

$$QDD_{it} = QCT_{it} + QFT_{it} + QIU_{it} + QSW_{it} + QES_{it} ; \tag{15}$$

Exports (if $i \in I_{c1}$)

$$QX_{it} = QTS_{it} - QDD_{it} ; \tag{16}$$

Per capita expenditure on i^{th} commodity

$$E_{it} = QC_{it} * RP_{it} ; \tag{17}$$

Self-sufficiency ratio

$$SSR_{it} = QDS_{it}/QDD_{it} ; \quad (18)$$

Production cost

$$PC_{it} = QP_{it} * UPC_{it} ; \quad (19)$$

Total revenue

$$TR_{it} = QP_{it} * FP_{it} ; \quad (20)$$

Net revenue

$$NR_{it} = TR_{it} - PC_{it} ; \text{ and} \quad (21)$$

Total area harvested

$$A_t = \sum_{j \epsilon I_c} A_{it} . \quad (22)$$

The variables are defined as:

I_c is agricultural crops included in the model,

I_{c1} is commercial agricultural crops,

I_{c2} is noncommercial agricultural crops (feed used on the farm),

A_{it} is area harvested for i^{th} crop,

AG_{it} is growth rate of area harvested for i^{th} crop at constant prices,

FP_{it} is farm price of i^{th} crop,

FP_{jt} is farm price of j^{th} competing crop,

n_{ii} is area response elasticity of i^{th} crop,

n_{ij} is area response elasticity of j^{th} competing crop,

Y_{it} is average yield of i^{th} crop,

YG_{it} is average yield growth rate of i^{th} crop at constant prices,

m_{ii} is yield response elasticity of i^{th} crop,

m_{ij} is yield response elasticity of j^{th} competing crop,

QP_{it} is production of i^{th} crop,

QBS_{it} is beginning stocks of i^{th} crop,

QES_{it} is ending stocks of i^{th} crop,

QDS_{it} is domestic supply of i^{th} crop,

QM_{it} is imports of i^{th} crop, $i \in I_{c1}$,

K_{it} is quantity of imports of i^{th} crop (exogenous),

QTS_{it} is total supply of i^{th} crop,

QC_{it} is per capita consumption of i^{th} crop,

RP_{it} is retail price of i^{th} crop,

RP_{jt} is retail price of j^{th} competing crop,

e_{ii} is own-price elasticity of demand for i^{th} crop,

e_{ij} is cross-price elasticity of demand for i^{th} crop,

η_i is income elasticity of demand for i^{th} crop,

QCT_{it} is total food consumption of i^{th} crop,

POP_t is population,

QFD_{it} is feed demand of i^{th} crop,

FC_{it} is conversion coefficient of i^{th} crop in feed units,

LPG_t is growth rate of livestock production, which is also equal to growth rate of feed requirements,

FR_{it} is percent of i^{th} crop in the feed ration,

QIU_{it} is industrial use of i^{th} crop,

IUR_{it} is ratio of industrial use to production of i^{th} crop,

QSW_{it} is seed, waste, and other use of i^{th} crop,

SWR_{it} is ratio of seed, waste, and other use to production or consumption,

SR_{it} is ratio of ending stocks to production or consumption,

QDD_{it} is domestic demand of i^{th} crop,

QX_{it} is exports of i^{th} crop,

E_{it} is per capita expenditure on i^{th} commodity,

QC_{it} is per capita consumption of i^{th} commodity,

SSR_{it} is self-sufficiency ratio for i^{th} crop,

PC_{it} is production cost of i^{th} crop,

UPC_{it} is unit production cost of i^{th} crop,

TR_{it} is total revenue of i^{th} crop,

NR_{it} is net revenue of i^{th} crop, and

A_t is total area harvested.

Livestock Sector. Included in the model are beef, pork, poultry, other meat, eggs, and milk. These are produced in the state sector and in personal plots. Production of these commodities depends on livestock production growth rates and own- and cross-farm livestock prices (Eq. 23 and 24). Total production is the sum of production in the state sector plus personal plots (Eq. 25). Since Lithuania exports livestock products, imports are generally zero. However, imports are included as exogenous to accommodate any government policy changes to import livestock products.

Similar to total production, total per capita consumption comes from both the state sector and personal plots. By-products of livestock product processing such as bone meal, egg shells, and dry milk powder are used as supplements in feed mixture to increase the nutrient value of feed. These by-products are included as feed from animal products in Equation (34). These feed by-products are expressed in the meat-equivalent units of respective products to obtain the total demand for livestock products. The rest of the livestock components are similar to the crop sector components, including the computation of aggregate performance measures.

The livestock model equations are formulated as:

Production in the state sector

$$QPS_{it} = QPS_{it-1} * (FP_{it}/FP_{it-1})^{n_{ii}} * \prod_{j \in I_\ell} (FP_{jt}/FP_{jt-1})^{n_{ij}}, \qquad i \neq j; \tag{23}$$

Production in the personal plots

$$QPP_{it} = QPP_{it-1} * (FP_{it}/FP_{it-1})^{n_{ii}} * \prod_{j \in I_\ell} (FP_{jt}/FP_{jt-1})^{n_{ij}}, \qquad i \neq j; \tag{24}$$

Total production

$$APT_{it} = QPS_{it} + QPP_{it}\ ; \tag{25}$$

Beginning stocks

$$QBS_{it} = QES_{it-1}\ ; \tag{26}$$

Domestic supply

$$QDS_{it} = QPT_{it} + QBS_{it}\ ; \tag{27}$$

Imports

$$QM_{it} = K_{it}\ ; \tag{28}$$

Total supply

$$QTS_{it} = QDS_{it} + QM_{it}\ ; \tag{29}$$

Per capita consumption from state sector

$$QCS_{it} = QCS_{it-1} * (RP_{it}/RP_{it-1})^{e_{ii}} * \prod_{j \in I_\ell} (RP_{jt}/RP_{jt-1})^{e_{ij}} * (I_t/I_{t-1})^{\eta_i}, \qquad i \neq j; \tag{30}$$

Per capita consumption from the personal plots

$$QCP_{it} = QCP_{it-1} * (RP_{it}/RP_{it-1})^{e_{ii}} * \prod_{j \in I_\ell} (RP_{jt}/RP_{jt-1})^{e_{ij}} * (I_t/I_{t-1})^{\eta_i}, \qquad i \neq j; \tag{31}$$

Total per capita consumption

$$QC_{it} = QCS_{it} + QCP_{it}\ ; \tag{32}$$

Total food demand

$$QCT_{it} = QC_{it} * POP_t ; \quad (33)$$

Feed from animal products

$$QFD_{it} = F_{it} ; \quad (34)$$

Ending stocks

$$QES_{it} = QCT_{it} * SR_{it} ; \quad (35)$$

Domestic demand

$$QDD_{it} = QCT_{it} + QFD_{it} + QES_{it} ; \quad (36)$$

Exports

$$QX_{it} = QTS_{jt} - QDD_{it}; \quad (37)$$

Per capita expenditure on the i^{th} commodity

$$E_{it} = QC_{it} * RP_{it} ; \quad (38)$$

Self-sufficiency ratio

$$SSR_{it} = QDS_{it}/QDD_{it} ; \quad (39)$$

Production cost

$$PC_{it} = QPT_{it} * UPC_{it} ; \quad (40)$$

Total revenue

$$TR_{it} = QPT_{it} * FP_{it} ; \text{ and} \quad (41)$$

Net revenue

$$NR_{it} = TR_{it} - PC_{it} . \quad (42)$$

The variables are defined as:

I_t is livestock products included in the model,

QPS_{it} is production of i^{th} commodity from the state sector,

QPP_{it} is production of i^{th} commodity from the personal plots,

LPG_{it} is growth rate of production of i^{th} commodity at constant prices,

FP_{it} is farm price of i^{th} commodity,

FP_{it} is farm price of j^{th} competing commodity,

n_{ii} is supply response elasticity of i^{th} commodity,

n_{ij} is supply response elasticity of j^{th} competing commodity,

QPT_{it} is total production of i^{th} commodity

QBS_{it} is beginning stocks of i^{th} commodity,

QES_{it} is ending stocks of i^{th} commodity,

QDS_{it} is domestic supply of i^{th} commodity,

QM_{it} is imports of i^{th} commodity,

K_{it} is quantity of imports of i^{th} commodity (exogenous),

QTS_{it} is total supply of i^{th} commodity,

QCS_{it} is per capita consumption of i^{th} commodity from state sector,

QCP_{it} is per capita consumption of i^{th} commodity from personal plots,

RP_{it} is retail price of i^{th} commodity,

RP_{jt} is retail price of j^{th} competing commodity,

e_{ii} is own-price elasticity of demand for i^{th} commodity,

e_{ij} is cross-price elasticity of demand for i^{th} commodity,

η_i is income elasticity of demand for i^{th} commodity,

QC_{it} is total per capita consumption of i^{th} commodity,

QCT_{it} is total food consumption of i^{th} commodity,

QFD_{it} is feed demand from i^{th} livestock product (converted into units of the i^{th} product),

F_{it} is quantity of i^{th} commodity used for feed (exogenous),

SR_{it} is ratio of ending stocks to food consumption,

QDD_{it} is domestic demand of i^{th} commodity,

QX_{it} is exports of i^{th} commodity,

E_{it} is per capita expenditure on i^{th} commodity,

SSR_{it} is self-sufficiency ratio for i^{th} commodity,

PC_{it} is production cost of i^{th} commodity,

UPC_{it} is unit production cost of i^{th} commodity,

TR_{it} is total revenue of i^{th} commodity, and

NR_{it} is net revenue of i^{th} commodity.

Other Food. Foods not included in these crop and livestock products constitute 40 percent of total food expenditures. These products include fish, fruits, coffee, tea, oil, canned food, but not beverages and tobacco products. Data for these items are derived from Department of Statistics (1990). In order to include these products, which are generally more processed, we include a simple aggregate function for other food expenditures. The underlying demand function is the same as that used for crops and livestock demand, but there are no data to separate price and quantity. The function is derived as:

$$OFE_t = QOF_t * POF_t = [K\ (POF_t)^e\ I^n_t\ ]\ POF_t$$

$$OFE_t = K\ (POF_t)^{e+1}\ I^n_t\ .$$

As in the previous derivation,

$$OFE_t = OFE_{t-1}\left(\frac{POF_t}{POF_{t-1}}\right)^{e+1}\left(\frac{I_t}{I_{t-1}}\right)^n$$

where OFE_t is other food expenditure in period t, POF_t is other food price in period t, I_t is income in period t, e is price elasticity, n is income elasticity, and K is constant. Although the level of the aggregate price POF is not known, assumptions are made about the growth rate of POF starting in 1991.

Exogenous Assumptions

The structure of commodity supply and demand requires a set of own- and cross-price elasticities. The production and consumption relationships in the commodity sector of the model are all based on constant elasticity functions, but the computer program permits the researcher to change the elasticities across time.

The supply and demand elasticities for the Soviet Union and Eastern Europe reported in Sullivan, Wainio, and Roningen (1989) are used for this study, since no such estimates are as yet available for Lithuania. In some instances these elasticities are adjusted, based on the nature and structure of Lithuanian production and consumption patterns. Supply elasticities included are for area and yield. Base values of these elasticities are given in Tables 1 and 2. Since area and yield elasticities were not separated in the study by Sullivan, Wainio, and Roningen (1989), we assumed that two-thirds of the supply response was from yield and one-third from area harvested. Demand elasticities used in this study are reported in Tables 3 and 4, most of which are largely taken from Sullivan, Wainio, and Roningen. The livestock product demand elasticity matrix includes only the cross-price elasticities for meat.

Table 1. Agricultural commodity supply elasticities

	Wheat Price	Rye Price	Barley Price	Oats Price	Other Grains Price	Potato Price	Sugar Beet Price	Flax Price	Vegetable Price
Area Elasticities									
Wheat	0.080	-0.017			-0.003				
Rye	-0.027	0.117			-0.003				
Barley	-0.027		0.117		-0.003				
Oats	-0.027	-0.030			-0.003				
Other Grains	-0.010	-0.010			0.100				
Potatoes	-0.010	-0.023				0.083	-0.030	-0.025	
Sugar Beets						-0.030	0.067	-0.015	
Flax						-0.025	-0.015	0.050	
Vegetables	-0.010	-0.023							0.083
Yield Elasticities									
Wheat	0.170	-0.033			-0.007				
Rye	-0.053	0.233			-0.007				
Barley	-0.053		0.233		-0.007				
Oats	-0.053	0.060		0.233	-0.007				
Other Grain	-0.020	-0.020			0.200				
Potatoes	-0.020	-0.046				0.166	-0.060	-0.050	
Sugar Beets						-0.060	0.133	-0.030	
Flax						-0.050	-0.030	0.100	
Vegetables	-0.020	-0.046							0.166

Table 2. Livestock and milk products supply elasticities

	Beef Price	Pork Price	Poultry Price	Other Meat Price	Egg Price	Milk Price	Wheat Price	Barley Price	Potato Price
Beef	0.30	-0.05	-0.03	-0.02		0.10		-0.01	
Pork	-0.02	0.45	-0.07				-0.03	-0.03	-0.04
Poultry	-0.06	-0.07	0.70				-0.03	-0.09	
Other Meat	-0.02			0.35			-0.03	-0.03	
Eggs					0.35		-0.02	-0.02	
Milk	0.04					0.30	-0.01	-0.01	-0.01

Table 3. Agricultural commodity demand elasticities

	Wheat Price	Rye Price	Barley Price	Oats Price	Other Grains Price	Potato Price	Sugar Price	Flax Price	Veg. Price	Income
Wheat	-0.03	0.06				0.03				0.21
Rye	0.10	-0.35				0.10				0.15
Barley	0.10		-0.35			0.10				0.15
Oats		0.15		-0.35		0.10				0.10
Other Grains	0.10	0.10			-0.35					0.15
Potatoes	0.04					-0.30			0.15	0.11
Sugar							-0.30			0.30
Flax								-0.15		0.15
Vegetables		0.04				0.15			-0.3	0.11

Table 4. Livestock products demand elasticities

	Beef Price	Pork Price	Poultry Price	Other Meat Price	Egg Price	Milk Price	Other Food Price	Income
Beef	-0.02	0.06	0.03	0.02				0.09
Pork	0.02	-0.18	0.02	0.02				0.12
Poultry	0.06	0.15	-0.25					0.04
Other Meat	0.03	0.02		-0.15				0.10
Eggs					-0.10			0.10
Milk						-0.11		0.11
Other Food							-0.25	0.25

A two-stage budgeting process is assumed, where expenditures are first allocated to each food group and then allocated among commodities within each group to allow substitution among commodities in each food group. This is realistic and is a practical necessity, due to the unavailability of cross-price elasticity estimates for some products. We assume there is limited substitution between livestock products and other food products because of the limited availability of vegetables and fish, the relatively high levels of potato consumption, and the rationing of grain products and sugar. Sensitivity testing can later be conducted on shifts in budget allocation that may occur in response to higher food prices.

On the supply side, normal area and yield growth assumptions are shift variables independent of prices. These growth assumptions are based on historical data and capture the government's influence through investments in area expansion and technology research as well as policies that could shift the structure of production.

Assumptions about certain policies, macroeconomic variables, and other pertinent variables were made to generate the endogenous variables in the projection period. Stock policy is based on historical data. Generally, a stock ratio was computed relative to either production or consumption. The choice of production or consumption depends on the particular commodity. A similar fixed ratio procedure was followed to compute seed and waste.

The production cost growth rate was assumed to increase at a rate proportionate to the inflation rate for the projection period. Farm prices were projected based on procurement price policy changes in 1990 and for later years taking into account general inflation and production cost growth rates. Farm price levels for various commodities are reported in Table 5. The Lithuanian government introduced consumer (retail) price reforms in March 1991. Specifically, the government increased grain products prices by an average of 220 percent, potato prices by 173 percent, vegetable prices by 226 percent, meat product prices by an average of 382 percent, egg prices by 195 percent, and milk prices by 300 percent. It is assumed that beyond 1991 these prices will increase at a rate proportionate to the general inflation rate. The retail price levels for various commodities are reported in Table 6. Retail prices of grain and milk products are expressed in equivalent prices of the respective raw materials.

For certain commodities, the government institutes export and import policies. In the case of grains, exports are assumed to be zero in the projection period because Lithuania depends heavily on grain imports for livestock production. In the case of meat and milk products, imports are assumed to be zero because Lithuania exports and there is no need to import these products.

Table 5. Farm prices for major agricultural commodities

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
						(rubles per metric ton)					
Total Grains	172	157	162	160	163	250	287	329	356	374	393
Wheat	189	173	179	177	178	275	316	362	391	412	432
Rye	155	141	147	144	146	225	258	296	320	337	353
Barley	181	165	171	168	170	262	301	344	373	392	412
Oats	103	94	98	96	97	150	172	197	213	224	235
Other Grains	224	286	204	221	231	350	402	460	498	524	550
Potatoes	132	171	156	186	199	230	264	302	327	344	361
Sugar Beets	66	61	60	67	65	74	85	97	105	110	116
Sugar	66	61	60	67	65	74	85	97	105	110	116
Flax	1,256	1,113	1,308	1,313	1,479	1,750	2,012	2,304	2,494	2,624	2,753
Vegetables	251	273	325	342	408	420	483	553	598	629	660
Total Meat	5,217	4,908	5,006	5,358	5,415	5,652	6,499	7,442	8,056	8,475	8,890
Beef	5,217	4,908	5,006	5,358	5,415	5,652	6,499	7,442	8,056	8,475	8,890
Pork	5,417	5,153	5,256	5,626	5,686	5,935	6,825	7,814	8,459	8,899	9,335
Poultry	4,434	4,172	4,255	4,554	4,603	4,804	5,524	6,325	6,847	7,203	7,556
Other Meat	2,659	2,719	2,706	3,283	3,301	4,306	4,952	5,670	6,137	6,547	6,773
Eggs	94	87	91	87	87	90	103	118	128	134	141
Milk	383	345	344	371	371	375	431	493	534	562	589

Table 6. Retail prices for major agricultural commodities

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
						(rubles per metric ton)					
Total Grains	165	150	152	150	151	160	513	594	648	684	721
Wheat	181	165	166	165	166	176	564	653	712	753	792
Rye	149	135	137	135	136	144	462	535	583	616	649
Barley	173	157	160	157	158	168	537	622	678	716	754
Oats	99	90	91	90	91	96	309	358	390	412	434
Other Grains	165	150	152	150	151	160	513	594	648	684	721
Potatoes	120	150	140	170	180	230	630	729	795	840	885
Sugar	780	780	780	780	780	840	162	187	204	216	227
Flax	1,130	1,002	1,177	1,182	1,331	1,557	3,460	4,007	4,368	4,617	4,862
Vegetables	210	220	270	275	350	375	1,225	1,418	1,546	1,634	1,720
Total Meat	2,159	2,226	2,394	2,416	2,566	2,605	12,578	14,563	15,874	16,779	17,668
Beef	2,151	2,219	2,383	2,409	2,561	2,600	12,548	14,531	15,839	16,742	17,629
Pork	2,258	2,329	2,502	2,529	2,689	2,730	13,176	15,257	16,631	17,579	18,510
Poultry	1,828	1,886	2,025	2,048	2,177	2,210	10,667	12,352	13,464	14,231	14,986
Other Meat	2,151	2,219	2,383	2,409	2,561	2,600	12,548	14,531	15,839	16,742	17,626
Eggs	90	85	87	84	84	88	260	301	328	347	366
Milk	210	210	210	210	210	210	500	579	631	667	702

To determine the feed demand of individual crops, the growth rates of individual livestock commodities were computed from historical data and projections of livestock commodity production. Then the aggregate growth rate of livestock production was calculated as a weighted average of individual livestock commodity growth rates. The weights are based on feed requirements per production unit of individual livestock commodities. Individual crops used for feed were converted into common feed units. The conversion coefficients were taken from *Recommended Feed Rations for Livestock for 1986-1990*, by the Lithuanian Institute of Livestock Breeding. Total feed consumption in feed units in the historical period is the sum of the individual crops in feed units. Total feed consumption in the projection period was allowed to grow at the same rate as aggregate livestock production. Feed ration proportions were used to decompose the total feed requirement in the projection period into individual commodity feed consumption. The feed ration proportions denote the proportion of total feed (in feed units) provided by each commodity. Historical data on the feed ration were used to compute the average feed ration in the projection period. Changes in feed consumption can also be permitted by changing these proportions.

Certain macro assumptions were needed to project the endogenous variables. Population growth rate was assumed to be 0.9 percent in the projection period (LIAE 1988). Inflation and income growth rate assumptions were taken from Project Link World Outlook (1991) and were adjusted for changing food price policies. The income subsidy introduced prior to retail price reforms in March 1991 was added to the 1991 per capita income and was assumed to grow at the same rate as income over the projection period.

Empirical Results

The analysis results are summarized with aggregate measures in seven areas: consumption and expenditures, government subsidies, feed use, land use, exports, self-sufficiency ratios, and net farm income. Since the major increase in producer prices occurred in 1990 and the major increase in

consumer prices occurred in 1991, these years are emphasized in the discussion. The changes between 1991 and 1995, the last year of the projection, are also discussed in terms of potential trends in the major aggregates, given the projection assumptions that were made. It should be emphasized that all the results are also conditional on the parameter assumptions and must be interpreted within these limits. Specific commodity production and use results are summarized in Tables A.1 and A.2.

Consumption and Expenditures

Although there were significant price increases for potatoes, sugar and flax in 1990, the major consumer price increases occurred in 1991, ranging from 120 percent for sugar and flax to 383 percent for meat products. As a consequence, the per capita consumption levels of most foods are projected to decline by 9 to 13 percent in 1991 (Table 7). The exceptions are pork and eggs, which are projected to increase due to their being substituted for other livestock products. Potato consumption declines by less than 3 percent in 1991, due to substitution effects with wheat products and the fact that part of the price adjustment for potatoes occurred in 1990.

Per capita expenditures for all foods are projected to increase by 243 percent in 1991. The highest expenditure increases are for meats (381 percent) and the lowest for sugar (136 percent). The major shift of budget shares in total food expenditures is between meats and other food. In 1990 meat accounted for 31 percent of food expenditures and other food for 35 percent. The analysis indicates that this pattern will be dramatically reversed in 1991 (43 percent for meat and 26 percent for other foods) and beyond, as consumers forego the more processed and less basic foods in the other food category. Since expenditures for other food are estimated to increase by 159 percent in 1991 after an assumed price increase of 200 percent, the estimated decline in the quantity of other food per capita is about 41 percent. Within meats, budget shares shift to pork from other meats due to the substitution effects noted above. Expenditures per capita are projected to increase by nearly 50 percent between 1991 and 1995,

Table 7. Per capita consumption and expenditure for major agricultural commodities

	1989	1990	1991	1995	1990/89	1991/90	1995/91
Consumption		(kilograms per year)				(percent change)	
Grains and Grain Products	173.5	174.6	152.5	159.1	0.7	-12.6	4.3
Potatoes	155.3	150.3	146.4	150.2	-3.2	-2.6	2.6
Sugar	51.1	38.9	35.5	38.1	-23.8	-8.9	7.3
Vegetables	76.1	80.6	72.5	74.4	5.7	-9.9	2.6
Total Meat	84.0	85.9	85.4	89.5	2.3	-0.7	4.8
Beef	34.7	27.9	25.3	25.8	-19.6	-9.4	2.1
Pork	25.3	27.8	32.4	35.4	9.9	16.3	9.3
Poultry	10.6	11.0	10.5	10.6	3.9	-4.3	0.9
Other Meat	13.4	19.2	17.2	17.6	43.4	-10.4	2.4
Eggs	349.8	335.7	347.1	356.3	-4.0	3.4	2.6
Milk Products	448.7	453.9	410.5	421.3	1.2	-9.6	2.6
Expenditures		(rubles per year)				(percent change)	
Grains and Grain Products	26.6	28.3	79.3	116.4	6.7	179.9	46.7
Potatoes	27.9	34.6	92.2	133.0	23.7	166.9	44.2
Sugar	39.9	32.7	77.2	116.4	-17.9	136.1	50.7
Vegetables	26.7	30.2	88.8	128.1	13.3	194.0	44.2
Total Meat	214.3	222.8	1,071.9	1,580.1	3.9	381.1	47.4
Beef	89.0	72.6	317.5	455.5	-18.4	337.1	43.5
Pork	68.1	76.0	426.5	655.2	11.6	461.4	53.6
Poultry	23.0	24.3	112.1	159.0	5.5	361.9	41.8
Other Meat	34.3	49.9	215.9	310.5	45.6	332.3	43.8
Eggs	29.4	29.5	90.4	130.3	0.6	205.9	44.2
Milk Products	94.2	95.3	344.8	497.1	1.2	261.8	44.2
Other Food	261.0	321.2	824.1	1,228.4	23.1	156.6	49.1
TOTAL	644.8	726.3	2,493.4	3,668.2	12.6	243.3	47.1
Consumer Aggregates							
Food Expenditures (mil rb)	2,379.0	2,704.2	9,233.6	14,098.9	13.7	241.5	52.7
Basic Foods	1,693.6	1,762.9	6,930.5	10,518.8	4.1	293.1	51.8
Other Food	685.4	941.2	2,436.6	3,764.4	37.3	158.9	54.5
Food Subs Per Cap (rub/yr)	431.2	481.4	-1,537.6	-2,339.8	11.6	-419.4	52.2
Income Subs Per Cap (rb/yr)	0.0	0.0	685.7	1,218.0			77.6
Food Expenditures/Incomes (%)	27.0	26.9	56.7	47.0	-0.4	110.9	-17.1
Basic Foods	16.1	15.0	37.7	31.1	-6.6	151.3	-17.6
Other Food	10.9	11.9	19.0	16.0	8.8	59.9	-16.1

Table 7. Continued

	1989	1990	1991	1995	1990/89	1991/90	1995/91
	(million rubles per year)						
Government Subsidies							
Consumer Price Subsidy	1,032.9	1,212.1	-3,267.6	-5,110.1	17.4	-369.6	56.4
Income Subsidy	0	0	2,576.0	4,742.0			84.1
TOTAL	1,032.9	1,212.1	-691.6	-367.4	17.4	-157.1	-46.9

given the price and income growth assumptions used. This is lower than the projected growth in per capita income.

Consumer Aggregates

The estimated increase in total food expenditures from 1990 to 1991 is 246 percent. The higher percentage increase in expenditures for basic foods (303 percent) than for other foods (159 percent) again indicates the shift in expenditure patterns.

The food price subsidy is an understatement of the actual consumer subsidy, since it does not include the government's substantial processing subsidies. The subsidy is calculated as the difference between producer and consumer prices so it does not account for costs of processing and handling. Thus, when the per capita subsidy changes from 481 rubles in 1990 to minus 1538 rubles in 1991, it indicates that the consumer loss in 1991 is 2019 rubles per capita and that 1538 rubles per capita are available to cover the processing margin. These estimates also indicate that the income subsidy of 686 rubles in 1991 is about 34 percent of the foregone consumer subsidy.

The income subsidy for 1991 is estimated from information available on planned subsidies, and it is added to income from 1991 onward. It is assumed to grow over time at the same rate as wages.

The estimated increase in the percentage of income spent on food is from 27 percent in 1990 to 57.5 percent in 1991. This estimated increase may be exaggerated, since the 27 percent does not reflect goods purchased at higher prices in the private market (which should decline after the price increase); and the 57.5 percent must be interpreted as an upper limit, given the assumptions used in this analysis. For example, some consumers may shift expenditures from meats to grain products if they are available. It should also be noted that the percentage of income spent on basic foods increases more (17.5 to 42.6 percent) than the percentage spent on other foods (9.4 to 15 percent), due to the shift of budget shares noted above. The portion of income spent on food is projected to decline significantly from 57.5 percent in 1991 to 47.7 percent in 1995.

Government Subsidies

The estimated changes in government subsidies are very interesting in that income subsidy payments beginning in 1991 are less than the government savings from reducing the processing subsidies. This results in an overall decline in government subsidy costs of more than 1.9 billion rubles per year in 1991 compared to 1990. Information available on the actual cost of processing subsidies in 1989 (2.1 billion rubles) indicates that all or most of these costs can be covered by the spread between new consumer and producer prices. The spread for individual commodities will also have to be examined within this same context.

Feed Consumption

The changes in feed consumption after 1991 are driven by the pattern of growth in livestock production, which determines the growth in feed requirements, and the feed ration assumptions, which determine the distribution of feed requirements across various commodities (Table 8). Thus, from 1991 to 1995 there is about a 10 percent growth in total feed and in each component of feed. The actual data from 1989 and 1990 indicate that there are some shifts from year to year due to changes in crop production and feed availability.

Table 8. Feed consumption

	1989	1990	1991	1995	1990/89	1991/90	1995/91
	(thousand metric ton feed units)				(percent change)		
Feed crops	2,048.1	2,073.8	2,111.6	2,322.4	1.3	1.8	9.9
Potatoes	279.4	212.1	258.8	282.4	-24.1	21.1	9.9
Grains	3,628.5	3,378.0	3,541.1	3,894.6	-6.9	4.8	9.9
Total	5,956.1	5,663.9	5,909.6	6,499.4	-4.9	4.3	9.9

Land Use

Land use is determined primarily by area and yield growth assumptions, although price effects shift land use slightly. In particular, since grain prices increased much more than other crop prices in 1990, there is a small shift towards grain area beginning in 1990 and continuing to 1995 (Table 9). Total cropland harvested increases by about 6 percent over the period, while grain area increases by about 9.3 percent. Area harvested for potatoes, sugar beets, and flax remain fairly constant based on the assumption that declines observed in recent years will not continue.

Table 9. Land use

	1989	1990	1991	1995	1990/89	1991/90	1985/91
	(thousand hectares)				(percent change)		
Total Grains	1,125.1	1,096.9	1,119.5	1,199.2	-2.5	2.1	7.1
Potatoes	119.6	115.2	115.1	114.9	-3.7	-0.1	-0.2
Sugar Beets	34.3	32.5	32.5	32.1	-5.3	-0.1	-1.0
Flax	27.5	29.0	28.6	27.0	5.5	-1.4	-5.6
Vegetables	17.1	17.0	17.2	17.7	-0.6	1.1	3.2
Feed Roots	58.3	58.0	58.3	59.7	-0.5	0.6	2.4
Corn Silage	77.0	78.0	77.6	76.1	1.3	-0.5	-2.0
Grasses	828.5	725.0	730.8	754.6	-12.5	0.8	3.3
Total	2,287.4	2,151.6	2,179.7	2,281.5	-5.9	1.3	4.7

Exports and Imports

Net exports are measured in both quantity and value. The export value is measured with producer prices. The pattern of importing grains and sugar and exporting flax and livestock products continues in the projection period (Table 10). There is a projected decline in grain imports, since the estimated production growth is more rapid than the growth in food and feed consumption. There is a significant growth in egg exports, as projected production grows more than domestic consumption. The projected value of net exports increases by more than 70 percent between 1991 and 1995, as the cost of grain imports declines slightly and the value of livestock product exports increases substantially.

Table 10. Volume and value of net exports

	1989	1990	1991	1995	1990/89	1991/90	1995/91
Volume		(thousand metric tons)			(percent change)		
Grains	-1,260.0	-1,010.0	-1,066.0	-509.4	-19.8	5.5	-52.2
Sugar	-109.6	-67.0	-38.6	-52.1	-38.9	-42.5	35.0
Flax	3.3	3.5	2.7	3.1	5.4	23.5	16.0
Meat	168.1	149.0	185.1	200.4	-11.4	24.2	8.3
Eggs (mil units)	41.3	26.0	21.5	77.3	-37.0	-17.5	260.5
Milk Products	1,273.9	1,050.0	1,334.6	1,583.5	-17.6	27.1	18.6
Value			(million rubles)				
Grains	-226.9	-281.5	-355.2	-264.9	24.1	26.2	-25.4
Sugar	-7.1	-5.0	-3.3	-6.1	-30.4	-33.8	84.7
Flax	4.9	6.1	5.4	8.6	24.7	-12.0	58.6
Meat	917.7	846.0	1,187.0	1,740.7	-7.8	40.3	46.6
Eggs	3.6	2.3	2.2	10.9	-34.9	-5.1	393.1
Milk Products	112.4	157.5	181.1	247.7	40.2	15.0	36.8
Total Value	804.6	725.4	1,017.3	1,737.0	-9.8	40.2	70.7

Self-sufficiency Ratios

The self-sufficiency ratios are calculated as the ratio of domestic supply to domestic use. These ratios, of course, reflect net export patterns and remain similar to patterns of recent years. There is a projected increase in grain self-sufficiency, as grain imports decline, and a significant increase in the production of surplus milk products (Table 11).

Table 11. Self-sufficiency ratio of major agricultural commodities

	1989	1990	1991	1995	1990/89	1991/90	1995/91
			(percent)			(percent change)	
Total Grains	78.7	82.1	82.0	92.4	4.4	-0.1	12.6
Potatoes	101.0	101.1	100.1	100.0	0.1	-1.1	0.0
Sugar	47.5	59.4	71.9	65.9	25.1	21.0	-8.4
Flax	120.4	120.6	114.7	116.4	0.2	-4.9	1.4
Vegetables	99.0	99.0	94.0	101.2	-0.0	-5.0	7.7
Meat	151.2	142.3	153.5	153.6	-5.9	7.9	0.1
Eggs	103.2	102.1	101.6	105.5	-1.1	-0.4	3.8
Milk Products	163.1	148.4	165.8	174.4	-9.0	11.8	5.2

Net Farm Income

Net farm income is measured as gross revenue less total production cost. Since management and labor are included in the cost of production, this difference can be interpreted as the return to land and other fixed assets. The 1990 producer price increases were more than 50 percent for grains, 15 to 20 percent for other crops (except feed crops, which are not commercialized), 30 percent for sheep meat, and less than 5 percent for other livestock products. Thus, the major impact was on producers' income from grains, potatoes, flax and other meats, which increased by an estimated 268 percent, 56 percent, 27 percent and 105 percent, respectively (Table 12). The estimated income of other livestock producers actually decreased due to the higher cost of feed. From 1991 to 1995 income from flax and vegetables is projected to grow less rapidly than that from other crops, but all grow slower than the expected inflation rate. Livestock income is projected to grow by 70 percent over this period, which is also below the expected inflation rate.

Table 12. Net farm income

	1989	1990	1991	1995	1990/89	1991/90	1995/91
		(million rubles)				(percent change)	
Crops							
Total Grains	19.8	72.7	66.0	109.7	267.5	-9.2	66.1
Potatoes	24.1	37.5	34.3	62.6	55.8	-8.5	82.4
Sugar Beets	4.7	4.5	4.7	7.8	-4.7	5.6	65.7
Flax	19.9	25.2	29.1	41.9	26.7	15.5	43.8
Vegetables	6.3	6.5	7.1	10.3	3.0	9.5	44.2
Total Crops	74.8	146.4	141.3	232.3	95.8	-3.5	64.4
Livestock and Products							
Beef	611.3	536.8	597.8	968.1	-12.2	11.4	62.0
Pork	662.2	659.0	746.7	1,170.8	-0.5	13.3	56.8
Poultry	170.6	143.1	164.4	277.2	-16.1	14.9	68.7
Other Meat	28.5	58.4	41.8	107.0	104.8	-28.4	156.1
Eggs	33.8	35.6	35.4	65.4	5.4	-0.7	84.8
Milk Products	280.8	259.1	224.3	480.4	-7.7	-13.4	114.2
Total Livestock	1,787.2	1,692.0	1,810.4	3,069.0	-5.3	7.0	69.5
Total Net Farm Income	1,862.0	1,838.4	1,951.7	3,301.3	-1.3	6.2	69.2

Conclusions and Policy Implications

The results of this analysis provide some insights into the kinds of impacts that can be expected on producers, consumers, and the government's budget as a consequence of the 1990 producer price increases and the even more dramatic 1991 consumer price increases. The analysis also points to key areas of research that need to be undertaken to provide a more reliable set of behavioral assumptions and projection assumptions for this type of study. The analysis indicates, as expected, that the major impact of price reform is on consumer budgets. As noted in the previous section, the impact on consumer expenditures may be overstated, given the behavioral assumptions that were made. The estimated change in the proportion of income spent on food is larger than what has been observed in Poland after an even larger food price increase there in 1990. While consumer behavior and other factors affecting consumer decisions are not likely to be the same in Lithuania as in Poland, it is likely that our estimates do not

include sufficient substitution of budget shares among food groups and may use price elasticity parameters that are too low. In Poland there was an increase in food as a share of total expenditures from 39 percent in 1989 to 54 percent in 1990, mostly from expenditures on clothing, shoes, and housing (World Bank 1990). There was also a larger shift toward more consumption of cereals, which is an expected consumer reaction to large price increases. Analysis of consumer expenditure data in Lithuania is necessary in order to improve this analysis.

The new income subsidies are not intended to cover all the increase in food expenditures, but this analysis indicates the subsidies would only cover about 43 percent of the increase. If increased consumer expenditures for food are overstated, this percentage would be understated. The principal purpose of the price increases was to reduce or eliminate government subsidies for food procurement and processing. The estimated decline in government subsidies of 1.9 billion rubles indicates that this result can be achieved, and data on 1989 processing subsidies indicate that the spread between new consumer and producer prices is sufficient to cover all or most of these subsidies.

The 1991 increase in volume and value of livestock exports is primarily due to the decrease in domestic consumption a result of consumer price increases, so more livestock is available for export. This assumes, of course, that trade arrangements with other republics will make increased exports possible. Increased export value can be viewed as another benefit to the Lithuanian economy from consumer price increases. To see a more complete picture of the trade balance, more information is needed on the import of inputs other than feed grains as well as the costs of those inputs.

Another goal of price reform was to improve crop producer incomes and protect future crop and livestock producer incomes. The net farm income estimates indicate that grain, potato, and flax incomes increased after the 1990 price increases and livestock producer incomes declined only slightly. Generally, these incomes are expected to increase over the projection period but not as rapidly as the expected inflation rate. Cost projections are very crucial, especially in the years beyond 1991; and the great

uncertainty about growth in the cost of imported inputs makes the income projections very tenuous, at best.

This study has many limitations because it lacks sufficient data and previous research on producer and consumer response to economic and policy signals. But it is important to develop this type of analytical framework both to obtain early indicators of price reform impacts and to establish a methodical approach to the analysis of markets and prices. Sensitivity analysis can be conducted quite easily with our analytical system and would provide information on the effects of different behavioral or projection assumptions on the outcomes. But it is also essential to initiate the basic research that will provide more reliable data and parameters for this type of analysis.

APPENDIX

Table A.1. Crops supply and utilization

	1989	1990	1991	1995	1990/89	1991/90	1995/91
		(thousand metric tons)				(percent change)	
Total Grains							
Production	3,272.0	3,265.0	3,519.2	4,502.4	-0.2	7.8	27.9
Net Imports	1,260.0	1,010.0	1,066.0	509.4	-19.8	5.5	-52.2
Food Consumption	640.0	650.0	573.0	619.6	1.6	-11.8	8.1
Feed Consumption	3,480.3	3,245.0	3,408.0	3,748.2	-6.8	5.0	9.9
Potatoes							
Production	1,926.6	1,693.4	1,767.5	2,105.4	-12.1	4.4	19.1
Food Consumption	572.9	559.5	550.0	585.0	-2.3	-1.7	6.4
Feed Consumption	931.4	707.0	856.0	941.5	-24.1	21.1	9.9
Net Exports	32.0	30.1	0.0	0.0	-5.9	-100.0	0.0
Sugar (processed)							
Production (from beets)	79.0	78.0	78.6	86.2	-1.3	0.7	9.7
Production (from cane)	159.6	82.0	90.0	90.0	-48.6	9.8	0.0
Net Imports	109.6	67.0	48.8	62.4	-38.9	-27.1	27.8
Food Consumption	188.6	145.0	133.3	148.2	-23.1	-8.1	11.2
Flax							
Production	15.1	15.9	16.1	16.8	5.3	1.2	4.2
Industrial Use	11.5	12.0	12.9	13.4	4.3	7.3	4.2
Net Exports	3.3	3.5	2.7	3.1	5.4	-23.5	16.0
Vegetables							
Production	325.7	306.0	316.8	350.8	-6.0	3.5	10.7
Food Consumption	281.2	300.0	272.5	289.8	6.7	-9.2	6.4
Feed Roots							
Production	3,118.3	3,150.0	3,203.6	3,427.2	1.0	1.7	7.0
Feed Consumption	3,016.3	3,095.2	2,886.5	3,174.6	2.6	-6.7	9.9
Corn Silage							
Production	2,823.0	2,886.0	2,986.4	3,424.4	2.2	3.5	14.7
Feed Consumption	2,486.6	2,796.0	2,920.5	3,212.0	1.0	4.5	9.9
Grasses							
Production	2,516.6	2,530.0	2,612.5	2,970.1	0.5	3.3	13.7
Feed Consumption	2,486.6	2,510.0	2,595.9	2,855.0	0.9	3.4	9.9

Table A.2. Livestock supply and utilization

	1989	1990	1991	1995	1990/89	1991/90	1995/91
	(thousand metric tons)				(percentage change)		
Beef							
Production	206.9	180.0	187.4	205.3	-13.0	4.1	9.5
Food Consumption	128.2	104.0	95.0	100.6	-18.9	-8.6	5.9
Net Exports	74.2	67.1	92.2	100.0	-9.6	37.4	8.5
Pork							
Production	179.9	181.8	188.5	204.5	1.1	3.7	8.5
Food Consumption	93.4	103.6	121.6	137.8	10.9	17.4	13.3
Net Exports	81.9	68.7	65.3	61.8	-16.1	-5.0	-5.3
Poultry							
Production	52.7	53.3	56.8	65.4	1.1	6.5	15.1
Food Consumption	39.0	40.9	39.5	41.3	4.9	-3.4	4.6
Net Exports	9.7	5.9	9.4	16.5	-39.2	59.7	75.3
Other Meat							
Production	53.9	82.9	86.1	93.7	53.8	3.8	8.8
Food Consumption	49.4	71.5	64.6	68.6	44.7	-9.6	6.1
Net Exports	3.6	8.3	18.2	22.0	130.6	119.1	21.1
		(mil units)					
Eggs							
Production	1,330.7	1,273.0	1,329.4	1,464.9	-4.3	4.4	10.2

REFERENCES

Department of Statistics. 1990. *Consumption of Major Food Products in Lithuania.* Vilnius, Lithuania: Department of Statistics.

Lithuanian Institute of Agricultural Economics (LIAE). 1988. *Food Program for Lithuania from 1990-2000.* Vilnius, Lithuania: Lithuanian Ministry of Agriculture.

Lithuanian Institute of Livestock Breeding. 1986. *Recommended Feed Rations for Livestock for 1986-1990.* Vilnius, Lithuania: Lithuanian Ministry of Agriculture.

Meyers, W.H., and S. Devadoss. 1987. *An Evaluation of Crop and Fertilizer Price Policies in Indonesia: A Policy Model Exercise.* Unpublished CARD policy report. Ames: Center for Agricultural and Rural Development.

Meyers, William H. 1988. "Adaptive Modeling for Food Policy Analysis." Paper presented at the Center for Agro-Economic Research, Bogor, Indonesia, November 26.

Project Link World Outlook. 1991. *Countries and Regions.* Philadelphia: Department of Economics, University of Pennsylvania.

Sullivan, J., J. Wainio, and V. Roningen. 1989. *A Database for Trade Liberalization Studies.* ERS Staff Report AGES89-12. Washington, D.C.: ERS, USDA.

World Bank. 1990. *An Agricultural Strategy for Poland.* Report of the Polish and European Community. Washington, D.C.: World Bank.