V. Modeling Livestock/Poultry Production and Processing in Transition Economies

The Economic Research Service cooperated with Purdue University to develop a set of simulation models that provides a quantitative framework to assist in analyzing livestock/poultry producer and processor responses to alternative reform scenarios in five transition economies: Poland, Hungary, Romania, Russia, and Ukraine. The modeling framework incorporates characteristics of both general and partial equilibrium models. The models for Romania, Russia, and Ukraine also separate livestock/poultry production and processing into subsistence and commercial components. The models are used to simulate the disappearance of bottlenecks in factor markets, as well as price liberalization and reductions in marketing costs.

Introduction and Background

The Economic Research Service cooperated with Purdue University to develop a set of models to provide a consistent framework for analysis of questions that are unique to the production and processing of animal products in transition economies. The modeling framework relies on economic theory, country data, and qualitative country information to quantify the responses of livestock/poultry production and processing sectors in selected countries to exogenous price and policy shocks that accompany the transition process.

The transition economies of Poland, Hungary, Romania, Russia, and Ukraine are cast in a Ricardo-Viner Specific Factor trade model framework.[6] The empirical application of the Specific Factor model results in a set of theoretically consistent country models that include characteristics of both general and partial equilibrium models. The models depict both agricultural and nonagricultural sectors. Primary factor markets—land, labor, and capital— are included, with linkages between sectors and aggregate resource constraints explicitly recognized. The agricultural sector is disaggregated into livestock/poultry and crop production. Crops provide feed for livestock/poultry production. Animals are traded, retained in breeding herds, or slaughtered and processed into consumer goods. Processed consumer goods (meat and dairy products) are retailed domestically or exported.

The modeling framework allows simulation of exogenous changes in policies, resource endowments, factor prices, etc. The consequences of alternative market structures can be examined by imposing alternative closure and clearing rules. This approach is taken because transition economies' limited market experience precludes a demand/supply model based on time series data. Data consistent with a mathematical programming approach are available and were used in developing the country models. Nevertheless, data were often missing and qualitative judgments based on country expertise were required.

A comparison of scenario results with a base-year model solution allows calculation of the following:

• changes in equilibrium quantities of livestock and poultry production (cattle, hogs, poultry, and milk), and processing (beef, pork, poultry meat, and dairy products), and animal products consumption;

• changes in net trade position for live animals, meats (beef, pork, poultry), and dairy products;

• changes in factor intensities within livestock production and processing industries, and between meat production and nonagricultural sectors.

Thus, for a given market scenario, model results indicate whether production of a given species (cattle, hog, poultry, dairy) is growing or declining, and whether the species under production is being processed or traded live. Changes in factor intensities of livestock/poultry production and processing will provide insight into whether or not, for example, hog production is more, or less, labor or capital intensive. Decreases in the feed-to-animal ratio for

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[6] This class of trade models assumes that trade results when factor prices differ between regions; factor prices are based on factor endowments and productivity. One of the primary factors is assumed to be fixed, and specific to the production of a specified good (in these models that factor is capital). Other primary factors can be mobile across sectors or international borders. For further discussion see Paarlberg (1994), Sanyal and Jones (1982), and Jones, (1981).

hog production would suggest increasing efficiencies in hog production. Changes in capital stocks accumulation show redirection of investment, both within the meat production sector (between agricultural and nonagricultural sectors of a given country), and between the given country and the rest of the world.

The transition process itself imposes limitations on the set of country models. The models are based on neoclassical assumptions of rational, perfectly competitive, maximizing agents. While many of the unique characteristics of the sectors are incorporated into the models, some important features are omitted. The models ignore or imperfectly reflect many critical institutional failures presently hindering the transition process, and so may overstate the ability of agents to respond to changing conditions. The models assume representative agents when there is clearly great heterogeneity. Given such limitations, the models serve as a complement to country expertise.

Model Overview and Sector Linkages

The models use the structure of trade models presented in Jones (1981) and Sanyal and Jones (1982). (A detailed mathematical form appears in Appendix: Model Structure and Data Sources, page 72). All transition nations are assumed to be unable to affect world prices of traded goods. This assumption allows the research to focus on national model development instead of devoting resources to modeling the world market. The cost of this assumption is that world market price effects are ignored. Primary factors of production consist of labor, land, and sector-specific capital. Pure final goods are beef, pork, poultry meat, fluid milk, butter, cheese, and sugar. Goods used only in the production of other goods (pure intermediates) are oilseeds and meal, cattle, hogs, poultry, sugarbeets, roughage, pasture, and farm milk. The remaining goods are used both as intermediates and as final goods. These include grains, potatoes, roots/pulses, and a composite nonagricultural good.

Composite nonagricultural goods are further disaggregated into a composite traded good and a composite nontraded good. The composite traded good includes all nonagricultural goods used to produce or process agricultural goods, which are able to be transported across international borders. Included in the composite traded good are such inputs as fertilizer, pesticides, herbicides, petroleum goods, etc. The nontraded composite good includes such items as bank credit, veterinary services, storage,

transportation, electricity, etc., which by their nature are unable to be transported across international borders.

Figure V-1 provides an overview of the country model framework. Primary factors are combined with nonagricultural goods to produce crops, roughage, and pasture. These inputs together provide the feed necessary to produce livestock and poultry for slaughter or trade. The feed allocation by livestock type is allocated using animal budgets and information from in-country livestock experts. Animal production relies on feeds as well as labor, nonagricultural goods, and sector-specific capital. After adjusting for trade and breeding inventories, animals are slaughtered or provide farm milk. Farm milk is processed into a price-determined combination of fluid

Figure V-1—Schematic view of model structure
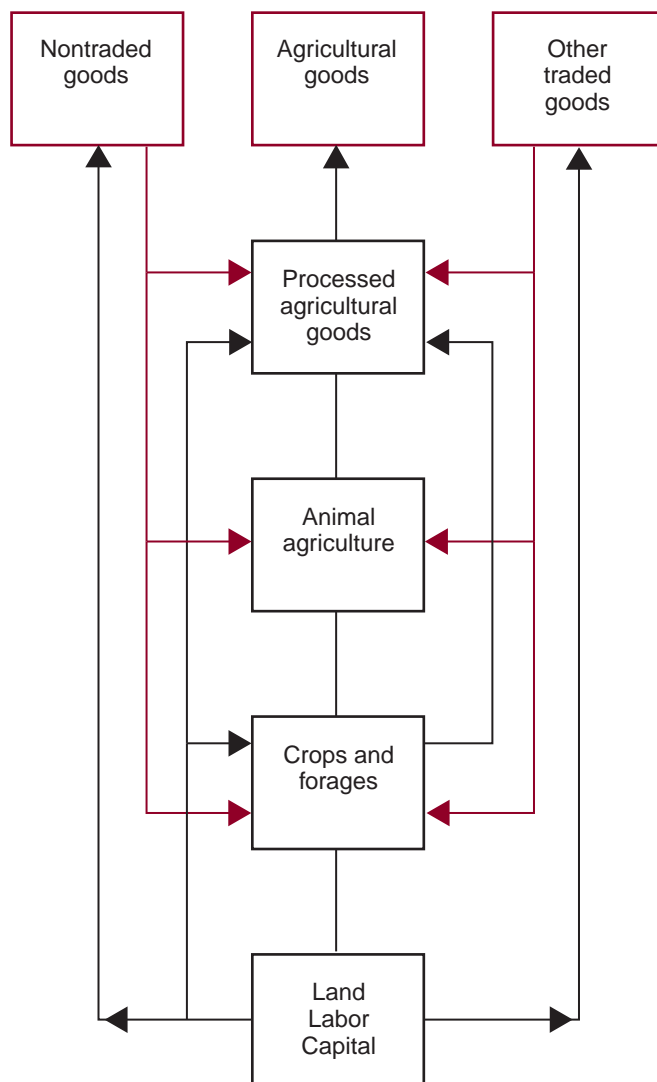
(retail) milk, butter, or cheese, using labor, capital, and nonagricultural goods. Slaughtered livestock and poultry become final goods—beef, pork, poultry meat.

Production of each crop relies on land, labor, capital, and nonagricultural goods. Roughage, pasture, and oilseeds are produced solely for feed use. Sugarbeets are either fed to livestock or sold to sugar processors. Grains, potatoes, and roots/pulses are used both as a feed and as a final good. Two crops—roughage and pasture—are always treated as nontraded agricultural goods. Sugarbeets, potatoes, and roots/pulses can be traded or not, depending on specific country practices. In Romania, Ukraine, and Russia all these crops are assumed not to be traded. In Poland and Hungary, only sugarbeets are modeled as nontraded crops.

Pasture and roughage are assumed to be consumed only by cattle. Oilseeds are converted to meal based on observed crushing yields and allocated to the various livestock types based on observed feeding practices. Similar feed ration allocations are used for the other feed ingredients.

In the livestock/poultry sectors, beginning inventories for cattle, swine, and poultry are taken from USDA's PS&D database. Cattle herd data show cattle "in milk" with the remaining cattle assumed for beef production. Poultry inventories are divided into layers and birds for meat. Slaughter is determined from the processing sector based on the output price for meat compared with the costs of production, including the price of the live animal. Final inventories are set using the ratio between the output for the animal and a weighted average of feed prices. Death rates are exogenous. When animals are traded, trade is the residual, with livestock prices linked to exogenous world market prices via policy interventions. Where animals are not traded or trade is set exogenously, the domestic animal price adjusts to clear the market. Live animals are not traded in the models for Romania, Russia, and Ukraine. Swine and birds are not traded in the models for Poland and Hungary, but cattle are traded. In all cases, meat is traded so meat prices are linked to the exogenous world price with trade quantities adjusting. This pattern is the opposite of the structure illustrated in the Sanyal and Jones (1982) model.

Milk produced at the farm goes into one of three outlets: milk for drinking, butter, or cheese. Milk is always assumed to be nontraded, while butter and cheese can be traded. The structure of the model allows for rates of return to differ between each dairy processing activity. Rates of return to fluid milk, butter, and cheese processing capital are thus important factors in output determination.

Meat production activities are more direct than dairy processing. Slaughtered cattle become beef, slaughtered hogs become pork, and poultry is transformed into poultry meat, all using labor, nonagricultural goods (traded and nontraded), and sector-specific capital.

Russian, Ukrainian, and Romanian agriculture is disaggregated into subsistence and commercial sectors because of between-sector differences in farming practices. Disaggregated data were obtained for Romanian agriculture. For the Russia and Ukraine models, because of data constraints, the private and state sectors were used as proxies for the subsistence and commercial sectors. Little precision is lost in such a data substitution, as most private sector output in Russia and Ukraine is the product of subsistence farms. Poland and Hungary also have various sized units ranging from subsistence farming to state farming, but in each case one structure tends to dominate. That is not the case in the other countries.

Technical Aspects of the Modeling Framework

The data needed to construct the production side of the model include the unit cost shares for the factors in each sector, per unit factor uses, and elasticities of substitution. In an ideal case, these data would be industry- and country-specific, but since not all the necessary data are available, some assumptions are necessary.

Country model results are largely driven by a predetermined set of unit cost shares for each output: crops, livestock, poultry, and processed products. Unit cost shares represent percentages (i.e., "shares") of total factor costs (i.e., costs of land, labor, capital, and nonagricultural goods), necessary to produce one ton of output. Some general patterns appear in the constructed unit cost share values:

• Because of low labor productivity, the labor cost shares are generally above those reported for Western nations despite the low wage.

• Subsistence agriculture shows higher labor cost shares than commercial agriculture. For example, subsistence grain production in Romania has a labor cost share of 24 percent versus 13 percent in commercial production.

• Crops have higher labor cost shares than animals for meat, for which the labor costs range from 1 to 14 percent.

• Labor cost shares in commercial processing are relatively low, for example, 7-15 percent in Romania. Usually one or more intermediates dominate the cost. In meat production, the dominant intermediate is the animal, with cost shares of 60-70 percent. In animal production, feed is the dominant cost share, ranging from 39 percent for peasant cattle to 94 percent for peasant swine.

• The cost shares of the "other traded good" component of the composite nonagricultural good (broken into "other traded good" and nontraded good) in livestock production are low. Again, there is a difference between commercial and subsistence agriculture, where subsistence agriculture makes limited use of nonagricultural inputs. The cost share of the other traded good component in crop production ranges from 30 to 75 percent because of the heavy use of chemicals, fertilizer, and purchased seed. Except for dairy products, the cost shares of the other traded good component in other sectors is 15 percent or less.

• A similar pattern is exhibited by the cost shares for the nontraded component of the composite nonagricultural input, but the magnitudes are smaller—10-20 percent for crops and less than 10 percent for other products.

Further details of unit cost share construction, together with assumptions that support construction of retail demand elasticities and elasticities of substitution, are described in the Appendix.

Overview of Scenarios

Chapters I-IV identified and described institutional and factor market barriers that currently hinder resource reallocation in transition economies. The five scenarios described below address unique transitional questions presented by livestock/poultry production and processing. The scenarios are each designed to simulate the impacts that could result from the elimination of factor market bottlenecks, price liberalization, and lower marketing costs.

Partial liberalization. Despite significant steps taken by most transition economies to liberalize prices and trade, various types of price supports, investment subsidies, and trade barriers remained in effect during the base period of the model. Russia and Ukraine directed significant subsidies to restructured state and cooperative farms, and continued to impose a variety of price and administrative trade controls. Romania maintained controls on consumer prices of bread and dairy products and producer prices of most grains and livestock products, and granted significant input and credit subsidies to producers. Poland and Hungary, after fully liberalizing their economies in the early 1990s, introduced a number of measures to protect producers' incomes in 1993. Income support measures took the form of minimum prices, high import tariffs, export subsidies, and credit subsidies.

Partial removal of government support was modeled for Romania. Romania is an obvious target for analysis, as the Romanian government removed many of the subsidies in 1997 and is unlikely to restore them to previous levels.

Reduced impediments to capital flows. One of the most urgent problems identified by producers in the transition economies is a lack of capital. There are two dimensions to this problem: one relates to a lack of financial capital and the other relates to capital as a stock. Capital stocks describe physical and human resources that generate flows of productive services. Financial capital is a collective term, used to identify a set of funds, often obtained through such instruments as bank loans, equity sales, bond issues, etc. Financial capital is typically converted into new stocks of physical capital. This scenario looks at both types of capital.

The first set of scenarios examine the impact of more readily available bank credit. Many producers and processors cite the lack of credit as the most serious obstacle to expansion. The cost of credit remains high, and banks are often unwilling to lend to agriculture at any price because of risk levels that are perceived to be unacceptably high. We tested this scenario for Romania and Russia. The results were similar for both countries, and we will present the results for Romania here.

In the second set of scenarios we ask the question: if financial capital were to become more readily available, where can it be invested to bring the greatest returns? There is already considerable interest among international agribusiness in investing in the livestock sectors of the transition economies. As these countries remove the institutional obstacles described in Chapter I, this interest will increase. Foreign investors are particularly interested in Poland and Hungary for two reasons: increased Polish and Hungarian access to EU markets, and the high probability of Polish and Hungarian accession to the EU.

After a decision is made to invest in the livestock/poultry sector, the issue of investment location within the market-

ing chain must be addressed; that is, at what level in the marketing chain are the returns to investment the highest. Scenarios depicted below use the Poland model to compare investment returns between hog production and pork processing.

Similar investment scenarios are simulated with the Russia model. Particular attention is focused on the poultry sector because of the significant level of recent Russian poultry imports, and in recognition of the ease with which poultry production and processing technology can be transported across international borders.

Reduced marketing costs. Marketing margins, particularly in the early transition period, were extremely wide. As described in Chapter III, the price difference between the farm level and the retail level is increased when costs of moving animal products through the marketing chain are increased by factors such as poor transportation and communications, uneven quality, poor market information, and high risk. Economists hypothesize that once these infrastructural shortcomings are overcome, the margins will decline. The result will be higher prices received by the producer and lower prices charged to the consumer.

This hypothesis is tested for Russia, Ukraine, and Romania. In all three countries, there remain several impediments to the efficient marketing and distribution of agricultural products. These impediments are generally less serious for Poland and Hungary.

Higher land prices. Land prices are generally low in the transition economies. In part, this is the result of a poorly functioning land market, but land prices are also influenced by the general low profitability of agriculture. Because land is cheap relative to other inputs, production in the transition economies tends to be extensive and yields are low. Land prices in all transition economies will likely rise as agriculture becomes more attractive to investors. This scenario is of greater interest for Poland and Hungary because of their imminent accession to the EU. One of the requirements of EU membership will be that all EU citizens will be able to buy land in Hungary or Poland, and the result will be upward pressure on land prices.

Lower employment in agricultural production. One agricultural growth dynamic frequently cited in the literature describes a process where labor is drawn off small family farm operations by more remunerative nonagricultural employment opportunities. Off-farm movement of labor begins a process whereby the agricultural labor population declines, average farm size increases, and farm productivity increases as returns to scale are realized. Our hypothesis was that this process would lead to increased profitability in a structurally altered agricultural sector supporting a reduced labor base.

We tested this scenario for Russia, Romania and Poland. All three countries have seen a rise in the share of agricultural labor in their total labor force since the beginning of the transition. Ukraine is in a situation similar to Russia, but Ukrainian employment data were not accurate enough to run this scenario. This scenario was not considered relevant for Hungary because of the significant decline in its agricultural labor force.