Agricultural Economics, 1 (1987) 273-290
Elsevier Science Publishers B.V., Amsterdam — Printed in The Netherlands

Wheat and Maize Price Policies in Hungary: Tradeoffs between Foreign Exchange and Government Revenue

Avishay Braverman[1], Jeffrey S. Hammer[1] and Jonathan J. Morduch[2]

[1]*Agriculture and Rural Development Department, World Bank, 1818 H Street N.W., Washington, DC 20433 (U.S.A.)*
[2]*Economics Department, Harvard University, Cambridge, MA 02138 (U.S.A.)*

(Accepted 24 March 1987)

Abstract

Braverman, A., Hammer, J.S. and Morduch, J.J., 1987. Wheat and maize price policies in Hungary: tradeoffs between foreign exchange and government revenue. Agric. Econ., 1: 273-290.

This paper reports on a methodology designed to examine the effects of selected agricultural policies in Hungary. The purpose of the paper is twofold. The first is to explain the methodology, dubbed multi-market analysis in previous work, which is implemented on personal computers to support discussions on policy reforms.

The second is to examine wheat and maize policies in Hungary. While the model is constructed to focus on these policies, it will also be possible to outline ways to use the model to address other problems.

Introduction

Multi-market analysis

The multi-market analysis is a tool for simulating the effects of agricultural price policies on outcomes considered of interest to policy makers. The policies which are considered are specific to the institutional structure of the economy. These frequently include taxes, subsidies, import and export restrictions or administratively fixed prices. The outcomes examined also reflect the specific concerns of the policy maker and usually include the patters of production and

0169-5150/87/$03.50

consumption, real income of various groups in society (distinguished by region or by income level), government finances such as tax revenue or subsidy costs and foreign exchange earnings (or costs) attributable to agricultural products.

The essential feature of the analysis is the recognition of the agricultural sector as a complex system. Through substitution effects between goods (in both supply and demand) and through income generation effects of price changes, a given policy can have a large number of direct and indirect consequences, including the impact on the urban sector. The multi-market approach can serve the analyst by providing a way of making assumptions explicit and by integrating various pieces of information which might be known from disparate sources into a consistent, easy to use and understand framework.

The guiding principle for this approach is to build the simplest model that will capture the salient features of the economy as they relate to the proposed set of policy options. In this way, the most important interactions between markets can be incorporated without solving a complete general equilibrium system. The method proceeds by assembling what is known about supplies and demands for the important commodities, the institutional structures of government policies and the mechanisms for market clearing. This information is arranged in a set of equations which is totally differentiated, so that changes in the outcomes of interest can be solved in terms of changes in the available policy options. Differentiation implies that the analysis is only relevant to small changes. However, there are practical ways to extend the analysis to handle large changes. On that, see below.

Since the resulting model is linear, it can easily be solved on a personal computer. "User friendly" software has been written which facilitates presentation of results and sensitivity analyses. It is hoped that, through experimentation with various policy options and various assumptions about the underlying parameters of the model, the analyst can develop a "feel" for the workings of the agricultural sector and its relation to the urban and external (export and import) sectors. On the one hand, this method fills a gap between commonly used methods of policy analysis: it extends single market analysis (consumer and producer surplus) to include substitution possibilities in production and consumption. On the other hand, it is both simpler to implement and easier to explain than large-scale linear programming and elaborate computable general-equilibrium models. Our approach emphasizes the positive analysis of consequences over the calculations of various social welfare aggregates. Although these models are often not of the full general-equilibrium type, it is possible to close them into general equilibrium. This generally entails the inclusion of factor markets which link the agricultural and industrial sectors. (For a detailed comparison of the multi-market approach to other methods, including effective protection rates, see Braverman et al. (1987c).)

The methodology described here has been used for the analysis of agricultural policies in Cyprus (see Braverman et al., 1987c) and Brazil (see Braverman et al., 1987b). Work done prior to these studies shared the multi-market orientation but was based on specific, nonlinear functional forms and was difficult to implement on personal computers. This earlier approach was taken in the analysis of Korea, Senegal, Sierra Leone, Malawi and Cyprus. For references to the above studies see Braverman et al. (1987a) and Braverman and Hammer (1986). For a more detailed methodological discussion comparing the two methods see our Cyprus paper (Braverman et al., 1987c). This line of research can be seen as one component of a larger process of policy design and analysis. The formulation of the model acts as a catalyst for discussions among policy advisors and policy makers. It requires focussing on key policy questions, key characteristics of the agricultural economy and underlying assumptions sometimes hidden between policy makers with interest in promoting different objectives. The "user friedly" software which lies at the heart of this analysis facilitates discussion by placing it on a common analytic ground. Having been engaged in discussions on policy reforms utilizing this approach in many developing countries, we found it very useful in improving discipline and clarity in the discussions.

Policy issues

Most agricultural products in Hungary are produced at fixed prices set by the government. As amply illustrated by the Agricultural Price and Foreign Trade Study prepared by the Agriculture Research Institute in Budapest (AKI, 1985), the absolute and relative prices of maize and wheat have been changing in comparison to world market levels for the twenty years up to 1983. (For example, wheat fell from protection of 113% of world prices in 1968 to 55% in 1983, while maize stayed at 85% of world price levels). This fact provides the motivation for the policies of 1983 examined here. What would happen if these prices, either singly or in combination, were to be increased? Some of the consequences follow immediately. If a single price, say maize, were to be increased, its own output would rise, and with it foreign exchange earnings and farm incomes. However, such a policy has other effects which result from the fact that maize is one part of the agricultural system as a whole. Two main indirect consequences can be expected to result from the price change. First, other field crops would have to be reduced in order to allow increased maize production. These also earn foreign exchange, and this loss should partly offset the direct effect. Second, maize is an input to the livestock sector and a price rise would increase costs. With fixed output prices, this would lead to reduced production and a further loss of foreign exchange. Also, with small farms producing more livestock products than field crops, the rise in feed costs will affect the relative incomes of the larger and small farm sectors.

The government earns revenue in units of foreign exchange through exports of agricultural commodities if world prices are higher than domestic prices.

With foreign exchange at a premium, additional earnings may even be worth subsidies to producers if these are paid in Forints. Thus, the objectives that the government may want to pursue are numerous and may involve explicit tradeoffs. The objectives which are influenced by the price policies are:

(a) foreign exchange earnings for the country as a whole;
(b) government revenues;
(c) maintenance of farm incomes, perhaps with a concern for the relative health of the large and small farms; and
(d) the cost of living as it is affected by the prices of consumer goods.

Wheat and maize prices cannot be expected to achieve all of these goals simultaneously. It is important, however, to see what the consequences of these policies might be.

Besides the policies discussed above, the model is able to address other issues. The software written to analyze the wheat and maize question can be used for other purposes which will not be discussed here. One further question which will be explored is the subsidy in fertilizer. The price of fertilizer is held lower than its cost at the expense of the government. With increases in the price of farm products, it may be possible to increase the selling price of fertilizer without much harm to farm output.

Therefore, the policy options are to raise the price of maize, wheat and fertilizer. The impact will be assessed in terms of foreign exchange, government revenue, farm incomes and the overall cost of living. The data utilized in this paper are for 1983. Specific policy recommendations may not apply to current conditions. As long as the basic structure of the economy remains the same, this model can be applied using current data.

Model structure

The model analyzes the affect on agricultural production of changes (primarily) in producer prices set by the government.* The sector is divided into large- and small-scale farm operations. The percentage breakdown of production by sector origin for 1983 are given in Table 1.

All prices other than those of poultry and fodder (discussed below) are directly controlled by the government. Supplies of each of the commodities are assumed to be determined so as to maximize profits in the activity. For the livestock products, this is assumed to be done for each good independently. For the field crop sector, there is assumed to be one sector-wide profit function whose arguments are the prices of all four outputs as well as the price of fertilizer. The issue of response to price incentives is an intricate one for Hungarian agriculture. It is clear that for small-scale farms, which are owned by private

*Hungarian economists have developed an elaborate model of Hungarian agriculture, the Hungarian Agriculture Model (HAM). For references to this model see Csaki (1981).

TABLE 1

Breakdown of production by sector origin, 1983

	Large-scale farms (%)	Small-scale farms (%)
Pork	43	57
Poultry	53	47
Beef	84	16
Milk	75	25
Wheat	100	0
Maize	92	8
Sunflower seed	100	0
Fodder	100	0

individuals, profit maximization and hence neoclassical price response is the appropriate description. We also assume this for large-scale farms, which include both cooperatives and state farms. The reality is that the managers of small farms may respond to a mixture of signals, including both prices and quantity targets, and may face, in Kornai's (1982) terminology, a "soft" budget constraint, i.e. no real financial viability constraint. However, as pointed out by Kornai and Matits (1984), the profit motive is more consistently asserted in state-owned agriculture as compared to state-owned industry. Therefore, we have decided to use the profit maximization assumption as an approximation. Our model allows, though, to make a distinction between the supply response to prices in the large-scale and small-scale (private) sectors. This may be explored in future work.

Final consumer demand is determined by the prices of all consumer goods. Demands are assumed to be derived from an indirect utility function whose arguments are prices and income. Other details of the supply and demand system are best explained in the context of the market clearing conditions for each good.

Market clearing conditions

Wheat. The supply of wheat is determined by the prices of all of the field crops as well as of fertilizers. It should be considered the derivative of the field crop profit function with respect to the price of wheat. Demand for wheat comes from two sources. First, as a final consumer good, demand for bread is determined by consumer prices. Second, wheat is also used as a feedstuff for livestock and this derived demand is a function of the prices of all other feeds as well as the output prices of the animal products. It can be considered the derivative of the livestock profit function with respect to the input price. The excess of supply over the two demands is exported. In symbols, the wheat market can be written:

$$S_w(P_w^p, P_m, P_s, P_h; P_f) = D_w^c(P_p^c, P_{pt}^c, P_b^c, P_{mk}^c, P_w^c) + \sum_i D_w^i(P_i^p, P_w^p, P_m, P_s, P_h) + \sum_i D_w^j(P_j^p, P_w^p, P_m, P_s) + X_w \quad (1)$$

S_w = supply of wheat; P_w = price of wheat; P_m = price of maize; P_s = price of sunflower seed; P_h = price of fodder (hay); P_f = price of fertilizer
D_w^c = consumer demand for bread
P_p = price of pork; P_{pt} = price of poultry; P_b = price of beef; P_{mk} = price of milk; P_w^c = price of bread.
(Note: the superscripts p and c on prices refer to producer and consumer goods. Where no superscript appears, no distinction is made.)
$D_w^{i,j}$ = feed demand for wheat in production of good i (beef, milk) or j = (pork, poultry) (Note: fodder is used only in production of the first pair. Feed demands are the sum of large- and small-scale demands.)

X_w = exports of wheat

Maize. The maize market clears in exactly the same way as the wheat market with the exception that final consumer demand for maize is negligible and therefore ignored. Exports adjust to equate supply and demand. The equation is therefore:

$$S_m(\cdot) = \sum_i D_m^i(\cdot) + \sum D_m^j(\cdot) + X_m \quad (2)$$

S = supply of maize
D_m^i = feed demand for maize for beef and milk production
D_m^j = feed demand for maize in pork and poultry production
(Note: all three functions above are dependent on the corresponding term for wheat.)
X_m = exports of maize

Sunflower seed. While not of critical importance in the current application, sunflower seed is included with the expectation of future work to explore its use as a high-protein substitute for soybeans. The market mechanism is the same as for the previous two goods, with the exception of consumer demand for oil, which is given exogenously. Again, exports to adjust to account for the difference between supply and demand.

$$S_s(\cdot) = \sum_i D_s^i(\cdot) \sum_j D_s^j(\cdot) + D_s^c + X_s \quad (3)$$

Symbols are as above.
D_s^c = exogenous consumer demand for oil (in seed equivalent).

Fodder. Fodder for ruminant animals consists of alfalfa and red clover hay. It is not traded internationally but used on large-scale, integrated farms or sold by cooperatives or state farms to their members or employees for private, small-scale production. Since it is used within the sector, its price adjusts to equate supply and demand. In symbols:

$$S_h(\cdot) = \sum_i D_h^i(\cdot) \tag{4}$$

Livestock products

With the exception of poultry, all of these markets have a similar structure. Supplies of all products are determined by the output price and the price of all relevant feedstuffs. Demands are determined by consumer prices and the excess of supply over demand is exported. Minor variations are discussed in each case.

Pork. The pork market is modelled as in the preceding paragraph. The equation is:

$$S_p^l(P_p, P_w, P_m, P_s) + S_p^s(P_p, P_w, P_m, P_s) = D_p^c(P_p^c, P_{pt}^c, P_b^c, P_{mk,p}^c, P_w^c) + X_p \tag{5}$$

$S_p^{l,s}$ = supply of pork in the large- and small-scale sectors
D_p^c = consumer demand for pork
X_p = exports of pork.

Poultry. The institutional structure in the poultry market is somewhat different than the other markets. The government has been promoting poultry exports and has been determining the export levels directly through trade agreements. The domestic market price, therefore, adjusts to equate domestic demand to the remaining supplies once these export quotas have been met. The market clearing equation is:

$$S_{pt}^l(\cdot) + S_{pt}^s(\cdot) = D_{pt}^c(\cdot) + X_{pt} \tag{6}$$

X_{pt} = exports set by the government.

Beef. In the analysis of the beef and milk markets, the distinction between large- and small-scale farms affects the nature of the production relation. For large-scale farms, the increased use of specialized breeding stock allows for the separation of beef and milk markets and they can be treated entirely independently. For small-scale farms, the two markets are more interconnected, as beef and milk are joint products. The beef market can be modelled as follows:

$$S_b^l(P_b^p, P_w^p, P_m, P_s, P_h) + S_b^s(P_b^p, P_w^p, P_m, P_s, P_h; P_{mk}^p) = D_b^c(\quad) + X_b \qquad (7)$$

Note that for small farms, supply (S_b^s) is a function of the producer price of milk (P_{mk}^p). The connection between the two is due to changes in stock resulting from a change in milk prices. An increase in milk prices will increase the stock of cattle, leading to higher beef production (after the year in which the stock adjustment is made).

Milk. As above, the distinction between large and small farms is important. The other characteristic of the milk market is that opportunities for exporting the excess of supply over demand for fresh milk are limited. This excess is converted into dry milk. In the model, this merely accumulates as inventory, though it is possible to include the valuation of this inventory at some shadow price deemed appropriate. The market looks as follows:

$$S_{mk}^l(P_{mk}^p, P_w^p, P_m, P_s, P_h) + S_{mk}^s(P_{mk}^p, P_w^p, P_m, P_w, P_h, P_b^p) = D_{mk}^c(\cdot) + I_{mk} \qquad (8)$$

I_{mk} = inventory accumulation of dry milk (in fresh milk equivalent).

Model solution and output

The first step in the solution of the model is to take the total derivative of each of the above equations. The terms in the resulting equation are rearranged in order to determine all supplies, demands, exports (except poultry) and the prices of fodder and poultry as functions of the producer prices and consumer prices (if different) of wheat, maize, sunflower seed, beef, milk, pork and fertilizer as well as the export quota on poultry. Expressions used in the solution are available in the Appendix of our Working Paper (Braverman et al., 1986). The software which has been developed makes the calculations automatically and transforms the results into policy relevant measures. These measures are the following:

(1) Foreign exchange earnings (*FE*) are the total value of exports evaluated at world prices. The equation for this is

$$FE = \sum_i P_i^* X_i \qquad (9)$$

where P_i^* is the world price of good i. The sum is over the goods: wheat, maize, sunflower, beef, pork and poultry.

(2) Government revenue (*GR*) is the net value of taxes (implicit) and subsidies on all goods, including fertilizer, which accrue to the government. The expression for this is:

$$GR=\sum_i (P_i^*-P_i^p)X_i+\sum_j (P_j^c-P_j^p)D_j^c+(P_f^p-P_f^c)\sum_k D_f^k \tag{10}$$

The first term is the earnings (or losses) due to exports where on each unit of export good i (X_i) the government earns the differences between the world price (P_i^*) and the producer price (P_i^p) which it paid to acquire the commodity. The second term is the net tax on consumer items, where the government receives consumer price P_j^c (which includes tax rate minus costs of processing and distribution) on each good for which it paid P_j^p. Since the consumer price which is used is net of processing and distribution costs, a good with no explicit tax or subsidy would have $P_j^c=P_j^p$ and no revenue results. Thus P_j^c is not necessarily the consumer price actually observed in markets, but is the implicit value of the producer good it is derived from. The third term is the cost of the fertilizer subsidy and is the difference between the price of acquisition for the government (P_j^p) and the price at which it sells to farmers (P_f^c) multiplied by total fertilizer demand (FD), which sums over k field crops:

$$FD=\sum_k^4 D_f^k \tag{11}$$

(3) Output of the two farm sectors. Changes in the value of output of large and small farms are calculated separately where

$$V^l=\sum_i P_i^p S_i^l \tag{12}$$

$$V^s=\sum_i P_i^p S_i^s \tag{13}$$

$V^{l,s}$ = value of output of large and small farms.

(4) Cost of living: Changes in the cost of living can be calculated by the equation:

$$\text{Percentage change in cost of living}=\prod_i (\Delta P_i^c/P_i)\Theta_i \tag{14}$$

where Θ_i is the share of the ith good in consumers' budgets. Unless a consumer price is changed explicitly, the only price that is likely to change due to the working of the model is that of poultry.

Data requirements

The construction of the model requires base level values for all quantities and prices as well as all relevant sets of own and cross price elasticities. All of the necessary base levels appear in the study of AKI (85). The elasticity estimates are a bit more problematic. The necessary sets of elasticities are: (1) own and cross price supply elasticities for field crops, (2) own and cross price demand elasticities for consumer goods, (3) own and cross price factor demand elasticities for feed grains for each livestock product, (4) own price supply elasticities for livestock products and (5) fertilizer demand elasticities for each field crop. The elasticities can be chosen to correspond to any time horizon. In this case, we focus on a short run (1–2 years) response.

Own price effects in each of the systems above are available from the work of the Agriculture Research Institute, Hungarian Ministry of Agriculture (see AKI, 1985), as well as work done by the Econometrics Laboratory in Budapest (for demand estimates see Meszaros (1985) and Muszely (1985)). Some cross-price effects have been estimated from data for this study, but by and large these numbers are difficult to come by. Without this information, the present study is similar to single market models. The strategy taken in this paper is to start with the case of zero cross price effects in every set of elasticities and explore the behavior of the model as a few selected elasticities are allowed to reflect more substitution possibilities. The primary substitution possibility is between wheat and maize in the supply system as well as in livestock factor demands. For the estimates used see the Appendix. Hammer (1986) characterizes alternative cross price patterns in the absence of direct information.

A general criticism of this approach is that it relies upon knowledge of elasticities (own and cross), which are known very imprecisely. As stated above, this criticism certainly applies in the Hungarian case. Our response is twofold. First, policy decisions have to be made regardless of the quality of data available, and will depend on these elasticities, whether known or not. It is important to make one's best guess as to the order of magnitude or the relevant range of parameters. Second, our "user friendly" software, which lies at the heart of our approach to policy dialogue, is used to explore these ranges quickly and efficiently through sensitivity analysis.

This sensitivity analysis lets one know how much one's policy advice depends on parameters one may not have confidence in. In fact, a secondary benefit of this analysis is to identify priorities for future research.

Results

Taken as a whole, the results provide a clear pattern of the agricultural sector's responses to prices, which can be used in discussion of policy. Conclusions concerning wheat and maize prices for the base period of 1983 are that a sensible recommendation is to raise producer prices. Given strong emphasis on government export earnings and hard-currency foreign exchange, the results show a higher priority for wheat prices than for maize in this regard. If maize prices are to be raised it is important that wheat prices are raised as well, although the reverse is not true.

This section will discuss the logic of the model with the use of one set of results which reflect a "moderate" degree of substitutability in the relevant

TABLE 2

Moderate substitution possibilities in supply, factor demand and consumer demand

	Policies[a]			
	Maize	Wheat	Both	Fertilizer
Production				
Maize	8.0	−3.51	−0.71	−1.26
Wheat	−3.71	6.5	4.01	−1.03
Beef	−0.75	−0.07	−0.23	0
Milk	−1.03	−0.24	−0.44	0
Pork	−0.63	−0.34	−0.41	0
Poultry	−0.10	−0.05	−0.07	0
Consumption				
Beef	0.03	0.02	0.02	0
Pork	0.03	0.02	0.02	0
Poultry	−0.17	−0.09	−0.11	0
Poultry price	0.30	0.16	0.20	0
Total foreign exchange	2.35	4.39	3.89	−1.92
Dollar foreign exchange	−0.17	4.69	3.51	−2.52
Government export revenue	−23.94	21.38	16.92	−16.33
Cost of fertilizer subsidy	2.10	1.27	1.47	−11.96
Value of large-scale production	2.88	2.48	2.50	−0.52
Value of small-scale production	−0.97	−0.41	−0.54	0

[a]Maize: raise maize producer price by 10%; wheat: raise wheat producer price by 10%; both: raise wheat producer price by 7.56% and raise maize producer price by 2.44%.

markets. The actual quantitative results of this case are tentative. They will be revised in light of clarification of data concerning fertilizer subsidies and feed demand for livestock. However, in comparisons of these results with those of other cases using different behavioral assumptions, the essential qualitative features of the model and of the effect of policy emerge clearly. Therefore, the sensitivity analysis is very important.

Table 2 presents the basic results for this case. "Moderate" substitution in supply and factor demand elasticities is limited to the cross price elasticities between maize and wheat. It uses the midpoint between the cases of no cross effects (implicit in single market analysis) and the theoretical maximum cross price elasticity for the given own price elasticities. This maximum is the highest value consistent with a well-defined profit maximization equilibrium for the farmers. The policies examined are (1) raising maize prices by 10%, (2) raising wheat prices by 10% and (3) raising both maize and wheat prices in proportion to the discrepancy between their domestic and world prices. This turns out to be an increase of about 2.5% for maize and 7.5% for wheat.

Maize price

Taking the maize price increase as an example, the effects of policy can be traced through each of the markets. On the supply of field crops, the increase in the maize price will lead to an increase in the supply of maize of 8% and a decrease in the supply of wheat of 3.7%. On the factor demand side, livestock producers will use more wheat and less maize domestically. Due to the relatively low demand elasticities which were assumed, this effect is modest. The net effect of these two responses is to increase exports of maize substantially (as a proportion of original exports) and to decrease those of wheat.

The increase in the price of feedgrain increases the cost of production of all livestock production. With fixed prices of output for beef, milk and pork, these activities will decline. With fixed consumer prices, this fall is taken out of exports, further reducing the value of exports. Poultry prices (with fixed export quotas) will rise but the upward shift in supply will lead to lower production and consumption. The increase in poultry prices will increase demand for other meats which further reduces their export (though this effect, with assumed parameter values, is extremely small).

The net effect on foreign exchange is to increase earnings of the agricultural sector by 2.35%. This can be compared to the case where no substitution is allowed (Table 3) in which earnings rose by 7.52%. Therefore, the substitution effects are seen to erode the direct effect on foreign exchange by more than two thirds.

When attention is turned to the government's revenue generated by exports, we find the substitution effects to be crucial. If the government were to pay a higher price for maize, the earnings per ton would be lower on maize exports. This effect is more than compensated by a much higher level of exports. However, the inclusion of the wheat effect leads to a net decrease in government earnings on agricultural commodities. The markup on wheat is greater than that on maize and the initial level of wheat exports is higher as well. The implicit tax revenues lost by the reduction of wheat exports is substantially higher than the extra earnings in the maize market itself. The effect is to reduce net revenues. This point is even stronger when it is realized that a higher percentage of wheat is exported to dollar area countries. Also included in the figure in Table 2 is the effect of meat exports on government revenues. Since the data appear to indicate that the government loses money on beef and pork exports (at least in slaughtered animals), the reduction in exports improves the earnings position. The effect is small, though, and swamped by the wheat loss.

TABLE 3

Sensitivity analysis

Case[a]	Policy[b]	Foreign exchange earnings	Government export revenues	Value of large-scale production	Value of small-scale production	Fertilizer subsidy cost
A	Maize	2.35	−23.9	2.88	−0.97	2.10
	Wheat	4.39	21.39	2.48	−0.41	1.27
	Both	3.89	16.92	2.50	−0.54	1.47
B	Maize	2.69	−21.57	2.88	−0.97	2.10
	Wheat	4.62	22.12	2.48	−0.41	1.27
	Both	4.15	17.92	2.50	−0.54	1.47
C	Maize	7.22	15.51	3.57	−0.97	3.76
	Wheat	7.86	34.07	3.17	−0.41	2.92
	Both	7.70	34.11	3.22	−0.54	3.12
D	Maize	−2.74	−66.1	0.18	−0.97	0.43
	Wheat	0.74	7.77	1.79	−0.41	−0.39
	Both	−0.11	−1.51	1.78	−0.54	−0.19
E	Maize	7.52	17.99	3.57	−0.97	3.76
	Wheat	8.08	34.87	3.17	−0.41	2.92
	Both	7.94	35.19	3.22	−0.54	3.12

[a]A = "Moderate" substitution in supply, feed demand and consumption; B = "moderate" substitution in supply and consumption; C = "moderate" substitution in feed demand and consumption; D = "maximum" substitution in supply and feed demand; E = no substitution in supply and feed demand.

[b]Maize: raise maize producer price by 10%; wheat: raise wheat producer price by 10%; both: raise wheat producer price by 7.56% and raise maize producer price by 2.44%.

Government costs are also affected by increases in the fertilizer deficit. Increased maize production (offset partially by decreased wheat production) increases demand for subsidized fertilizer, further increasing total fiscal costs.

The increased maize price has further effects on real incomes. Since field crops are grown primarily on large-scale farms while small-scale farms raise more livestock (as a proportion of output) the maize price rise benefits the former relative to the latter. As far as the cost of living is concerned, the only price which is allowed to rise is that of poultry, which rises by a modest 0.3%.

The above results are in the context of particular assumptions concerning the elasticities of supply and factor demand. Table 3 shows the values of selected results using a variety of assumptions concerning these elasticities. The main comparator cases are: (1) no substitution possibilities allowed, (2) substitution allowed in field crop supply but not in factor demands, (3) substitution allowed in factor demands but not in field crop supply and (4) maximum substitution allowed in both supply and factor demand. The following discussion of the results generalizes over these individual outcomes.

The above description of the effect of the maize policy is generally borne out in the sensitivity analysis. The extreme effects in government revenues appear to depend on sufficient cross price effect in supply rather than on factor demands (at least for the range of values examined here). With substitution possibilities near their maximum possible values, the effect of raising maize prices is to reduce foreign exchange earnings. With no substitution possibilities, few of the negative side effects emerge.

Wheat price

Raising the wheat price looks like a better policy over a wide set of assumptions. Since it earns more on world markets than maize, and the gap between domestic prices and world prices is larger, both foreign exchange earnings and the government's share of it increase with the wheat price in all the cases explored here. It is true that earnings are less with substitution than without, but the secondary effects are never large enough to overcome the direct effect.

Wheat prices have less effect on the livestock sector and therefore the increase is not as damaging to small-scale producers. Also, the foreign earnings due to wheat (and livestock) have a higher dollar component than those of maize.

Wheat and maize prices

Moving both prices together is a sensible policy, though it must be emphasized that wheat prices should be raised at least as much as maize if substitution possibilities exist. There appear to be more advantages in promoting wheat rather than maize.

Fertilizer price

The model has also been used to examine the effect of raising the fertilizer price. The results for this case are essentially independent of the elasticity assumptions, since none directly affect the fertilizer market. The direct tradeoff emphasized by these results is between government subsidy costs and foreign exchange earnings. It should be possible to combine increased fertilizer prices with increased output prices in order to save substantial government costs without jeopardizing export earnings.

Modifications and extensions

The personal computer version of this model allows for other policies to be explored than those considered here. The main piece of unfinished business is to look at a wider set of supply and demand elasticities. The analyses above were limited to examining the wheat/maize effects. Allowing for a fuller set of interactions could improve the story. One example would be that with knowledge of the substitution of wheat or maize with fodder, a differential between ruminant animal production and others will emerge. Raising grain prices might drive up the price of hay (by reducing the supply), which would make the cost of production high for beef and milk relative to pork and poultry. Many such interconnections can emerge with more information concerning the behavioral parameters included. It is also true that the model can be modified and extended to include additional considerations.

One possible modification is to model the sunflower seed market in more detail. Sunflower oil demand is not responsive to prices in this model, and this can affect export possibilities. Similarly, substitution with imported soybeans for feed can be explored with some modification of the model calculations.

A second possible extension is to split the livestock products into live animals for export and slaughtered animals. As pointed out by AKI (1985), increased profitable exports are possible for live animals to a larger extent than for meat exports. This distinction is not made in this version, though it can be adjusted to do so.

Third, the current model does not value dry milk which is not consumed domestically. This merely requires finding a correct shadow price for accumulated milk products.

Finally, in regard to export earnings, the use of labor in the model is not accounted for. If, say, the prices of field crops are raised, their output will rise and that of livestock products will fail. Since livestock production is more labor intensive than field crop production, this could lead to a net reduction in labor use. The model as currently designed does not account for the value of this released labor in alternative uses. It is possible, of course, that the released labor will not go to other activities (besides increased leisure), but ignoring it may lead to mistaken conclusions. This leads to the general issue of how the analysis in this model relates to the non-agricultural sector and points out some limitations of the analysis to which we now turn.

Limitations of the analysis

Partial equilibrium

While taking into account more substitution possibilities than single market analyses, the above model is still partial equilibrium in nature and cannot address certain problems that are essentially general equilibrium. The non-agricultural sector appears in this model only as a source of final consumer demand. All links on the factor side are ignored and questions that deal with factor flows between the sectors cannot be addressed without including them explicitly. The issue of labor mentioned above is one such issue. Another would be questions of investment choices, where increased profitability of the sector would draw investment resources. Due to the planning system in Hungary, it was judged that these considerations are not crucial. However, the warning must be given that the boundaries of the model may not coincide with the boundaries of the real-world problem and that the model will miss endogenous economic responses which may occur outside the sector.

Large versus small policy changes

Since the model is linear by virtue of the fact that it is derived from differentiating the market clearing conditions, it is a legitimate guide only for small changes in policies. It can give the relative magnitude of changes in important variables, i.e. the direction the economy would go from the base levels as policies are changed. It should not be used to extrapolate too far from the initial conditions. How far is "too" far is a matter of judgement. Large changes can lead to obviously suspect results, as the model will impose linearity in responses when the underlying supply or demand function is curved. It is generally the case that knowledge of these functions is limited to the neighborhood of the initial conditions, but models which are based on nonlinear systems may appear to behave better for larger policy changes.

In the Hungrian case, the issue of how large is large may be of some importance. If maize and wheat are close substitutes as feedstuffs, substantial shifts in their use may be expected if their relative price changes. For the very small changes allowed by the model, the cost of production of a livestock product rises in proportion to the share of the value of production an input is paid as the input price rises. If large substitution effects are possible, this share might be very sensitive to the relative price of the feedgrains. Therefore, the effect on livestock output of a single feedgrain price change may be less than that predicted by the current model for ranges of values of prices which may seem fairly modest. The effect of raising both prices, since relative shares would not change so much, would then be quite different from raising each individually, though the present model has similar outcomes for these two options. In this case, a "small" change is quite small indeed. Where this sort of substitution is not as extreme, the reliable range for the model is larger.

There are two possible ways in which the effect of this limitation can be reduced. The first is to anticipate large changes by modifying the elasticities used in the system. Larger policy changes should be accompanied by smaller assumed elasticities. The assumed elasticities can be based on a chosen functional form and taken to reflect the arc elasticities over the anticipated range rather than the point elasticities at the initial level.

The second way is to solve the model iteratively in small steps. A small change can be made and followed by a recalculation of levels of variables and possibly of elasticities corresponding to a particular chosen functional form before a second step is taken. This can be repeated for more small steps until the desired policy changes are reached. Subsequent work has resulted in the implementation of this method in the software.

It should be noted that all methods of analysis are valid only for such local changes, since the true underlying functions are almost never known for their whole ranges. The difference is that the present model makes this point explicitly and can give obviously poor results if misused.

Conclusions

The purpose of this paper was to illustrate the use of the multi-market method for analyzing agricultural price policies in the Hungarian case. It is important to emphasize that the results and policy recommendations are relevant only to 1983. Current policies can also be analyzed simply by replacing the data in the computer program with current data. This method and the software that goes with it should be used to facilitate the discussion of consequences of policies. We emphasize the discussion aspects as opposed to uncritical reliance on mechanical calculations.

An important criticism of this approach is that it takes too static a view of policy making. World prices will always figure prominently in analyses of this type. These prices, however, are subject to substantial fluctuations and uncertainty of predictions. Our ongoing research examines the creation of price policy rules in uncertain environments rather than setting prices at specific levels.

Acknowledgments

We are grateful to many Hungarian officials and academicians who supported us through discussions and advice during our mission. We are extremely grateful to the staff of the Agricultural Research Institute in Budapest (AKI), in particular Gyula Varga, Sandor Meszaros, Eva Borszeki and Gyorgy Rasko, who hosted our visit to Hungary and provided us with extremely useful information and advice. We would also like to thank Janos Kornai, Csaba Csaki, Ferenc Rabar, Gyorgy Szakolczai, Gyorgy Muszely, Marto Ballesteros and Wayne Ringlien for their support and advice.

Note

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Appendix: Supply and demand elasticities

The base case of the model was run with the following supply system:

Change in supply of:	With respect to price of:			
	Wheat	Maize	Sunflower	Fodder
Wheat	0.65	−0.37	0	0
Maize	−0.35	0.8	0	0
Sunflower	0	0	1.6	0
Fodder	0	0	0	0.15

The demand system used was:

Change in demand for:	With respect to price of:				
	Pork	Poultry	Beef	Milk	Bread
Pork	−0.52	0.1	0	0	0
Poultry	0.35	−0.55	0.03	0	0
Beef	0	0.1	−0.52	0	0
Milk	0	0	0	−0.22	0
Bread	0	0	0	0	−0.2