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The Place of Agriculture in the Development of Poland and Hungary: Lessons from a Computable General Equilibrium Model with Risk Considerations

INTRODUCTION

The possibility of the Central and Eastern European countries (CEECs) entering the European Union (EU) prompts the need for us to investigate their agricultural potential. Will they become importers or exporters of food products? Will their entry in the EU force a complete revision of the existing common agricultural policy (CAP)? These are questions that anybody interested in European agricultural policies may ask. At the same time, since the same kind of problem arises almost everywhere, the method used to find an answer may be of interest to almost any agricultural economist.

A traditional approach in this field consists of the building of general equilibrium models, which allow calculations to be made of equilibrium prices and quantities under different scenarios of trade liberalization. Such models, generally, are optimistic in suggesting that there are large benefits that the CEECs can derive from membership of the European Union (see, for instance, Folmer *et al.*, 1995). At the same time, in view of the large agricultural potential among the CEECs, there is concern both about the future of the EU farm sector and about policy issues, since it is commonly thought that applying the present CAP system to the CEECs would result in an enormous oversupply of agricultural products. As a consequence, recommendations often centre on the need for a change in the CAP, which should rely on market efficiency, rather than on price support, as the only possible way of capturing the potential benefits of an enlargement.

It is normally the case that general equilibrium models, based on standard theorems, lead to the conclusion that general welfare is superior when there is a customs union, rather than without, because there are fewer obstacles to exchange. Hence the typical suggestion that 'liberalization is good'. However, this conclusion depends on the assumption that the future is known with certainty, as usually hypothesized in the construction of such models. It is an assumption which is far from being justified in reality, since, in practice, decisions are taken under risk and uncertainty. As a consequence, the 'no profit' hypothesis cannot be met, and production is normally less than it would be if marginal cost equates demand. This is a case for state price intervention

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which, by reducing the cost of risk, would play the same role as productivity-increasing technical progress.

As a consequence of the above analysis, computable general equilibrium (CGE) models have to be modified, in order to take account of the effects of risk and uncertainty in production decisions. This is possible, but rarely done. In addition, it has been shown that to take uncertainty into consideration will, in general, modify the dynamic path of results. Uncertainty creates uncertainty, so that unregulated markets may end up in a situation less favourable, in respect of general welfare, than those which are regulated. This is particularly true of agricultural markets, where demand is rigid (Boussard, 1996).

For the present study, the classical general equilibrium model has therefore been modified, by explicitly introducing risk as a determinant of producers' decisions. It should be noted, at this stage, that the risk considered here is not the traditional technical risk (as exemplified, for instance, by meteorological variation), but rather the economic risk associated with price instability. The latter is not difficult to introduce into a CGE model, since the method follows from the basic equations of portfolio theory.

Such modified models have been applied to the present situation of two East European countries, Poland and Hungary.[1] To study the growth path of present economic systems the work was done in a dynamic perspective, by letting each fixed factor depend recursively on the equilibrium solution for the previous year, and making the estimates for the variability of prices on the basis of earlier fluctuations. In that way, the equilibrium path is calculated over a series of years. It is then possible to demonstrate that capital accumulation, growth and intersectoral transfers of resources can be affected, in a sensitive manner, by the nature of the trade regime and by price stabilization policies.

SCENARIOS AND METHODS

The general equilibrium models are based on social accounting matrices (SAMs) for each country. They are first solved under the standard conditions of the free market, on a 'no risk' basis, for comparison. This leads into the study of country growth, over a period of 10 years, by making the model recursive.

The next step is to establish a scenario under free market assumptions, but with decision makers having a relatively large degree of risk aversion. In that way 'all stable' scenarios are generated. Here prices are stable in the sense that foreign prices are kept constant, according to the tradition of CGE models, though they can alter in response to changes in the availability of fixed factors, as in the 'no risk' scenario. Now, however, decision makers are averse to such changes, and consider them detrimental.

In this context, the only source of variability is endogenous. It results from the adaptation of the economy to new conditions. But it was also necessary to examine the consequences of exogenous shocks affecting foreign agricultural prices, leading to the introduction of two additional scenarios. One, referred to as 'world prices random' is built with large shocks affecting both world and European agricultural prices (implying that the present EU price stabilization policy does not apply in the CEECs). The second, referred to as 'European prices stable' is made with the same shock only affecting world prices, but with EU agricultural prices remaining stable at the initial year level. It must be borne in mind that non-agricultural foreign prices are kept constant.

The CGE models used in this context are standard (de Janvry and Sadoulet, 1995), with CES production functions, and use of the 'Armington assumption', to make foreign trade dependent upon demand elasticity, and of the 'Fisher equation', to relate the general price index to the quantity of money. The models are particular, nevertheless, with respect to risk and recursivity assumptions.

INTRODUCING RISK

The central assumption here is that producers, instead of maximizing expected profits, maximize the certainty equivalent of these profits. In addition, according to the basic Markowitz model of portfolio selection, it is assumed that the certainty equivalent of the random profit z is given by $U = \bar{z} - A\sigma_z^2$, where σ_z^2 is the variance of z and $\bar{z}$ stands for the expected value of z, with A as a risk aversion coefficient.

Obviously, each of these assumptions is extremely contentious (though the notion of there being an aggregate risk aversion coefficient is perhaps the least audacious), since the 'mean variance model' has been the object of many criticisms. It is not possible to discuss these issues at length. Our only justification (which should be taken seriously) is that it is certainly better to take account of risk, even, in an imperfect way, than to neglect it completely. Once the two major assumptions above are admitted, the model modifications are straightforward. If one neglects covariances, with $z = pq - C(q)$, where p is the price, q the quantity, and C the cost (a function of q), one has $\sigma_z^2 = \sigma_p^2 q^2$, with σ_p^2 being the variance of prices, and $\bar{z} = \bar{p}q - C(q)$ if $\bar{p}$ and $\bar{z}$ are the expected values of p and z.

Reporting these expressions in U, and deriving with respect to $\bar{q}$, gives the producer's optimality condition:

$$C'(\bar{q}) = \bar{p} - 2A\sigma_p^2 q.$$

This expression is then used to compute the elements of the matrix of technical coefficients, instead of its traditional counterpart $C'(\bar{q}) = \bar{p}$, which is made use of when risk is neglected.

The production function now exhibits a profit, the magnitude of which is $2A\,\sigma_\pi^2 \bar{q}^2$. This profit is the entrepreneurial reward for taking risk, which has to be accounted for in the construction of the SAM matrix. Additional rows and columns have been defined, called 'risk in *xx*', where *xx* stands for agriculture, industry, services and other production activities. An estimate of the quantity $A\sigma^2 q^2$ for each activity has been made, on a rather arbitrary basis, with A being defined as the inverse of the average wealth in the industry, and other parameters determined by the necessity of balancing the SAM under examination.

At the same time, the corresponding column activities must spend their incomes somewhere. It has been assumed that 'risk' columns of the SAM were spending their incomes exactly as 'capital' columns would do. In that way, it is recognized that risk benefits are the reward of profit, and minimal changes are involved in the original SAM.

THE DYNAMICS OF THE CGE MODEL

Because risk takes place in time, it is practically impossible to set up a risk model without dynamic considerations. In the present case, the source of price variability cannot be anything other than time. Thus we have to take account of time to set up our experiment 'with' and 'without' risk. In order to make the model dynamic, first, one must derive the level of fixed factors in year t from the results of year $t-1$ and, second, specify how expectations are modified across time.

Factors are labour and capital. For labour, in Poland, the SAM allowed for a distinction between agricultural and non-agricultural labour. As a consequence, it was easy to define an elasticity of emigration from rural to urban occupations with respect to the price ratio of agricultural and urban wages. In Hungary, no such distinction between labour type was available. As a consequence, the total quantity of labour is kept constant, and the shift from agricultural and non-agricultural occupations is supposed to be instantaneous, and regulated by prices only. Actually, such an assumption is probably much more justified for Hungary than for Poland.

The basic recursive equation for capital is:

$$K_{it} = K_{it-1} - a_i K_{it-1} + I_{it-1},$$

where K_{it} is capital stock at date t for sector I; a_i the depreciation factor; I_{it} investment of sector I at date $t-1$ (I_{it} is given by the level of capital account activity I, with i being 'agriculture' or 'other'). This equation was used in its basic form in the Polish model, with agricultural savings financing agricultural capital, and non-agricultural savings, non-agricultural capital. In the Hungarian case, a complication arose from the fact that the SAM did not indicate anything about the origins of savings. Thus it was necessary to allocate savings and investment between the stocks of capital in four production activities. This was done through a portfolio sub-model allocating investment according to each sector's profitability (as measured by the corresponding 'price') and riskiness (measured by the price variability).

With respect to expectations, first, it must be noticed that there is an almost complete lack of coverage of expectations pertaining to the *mean levels* of prices in this model.[2] Since prices are always equilibrium prices, one is permanently within the framework of rational expectations, where agents accurately forecast the outcome of the equilibrium and take decisions on that basis. However, this is in some sense contradictory with the existence of risk, as introduced above. Actually, it is probably not unreasonable to assume that average prices are more or less rationally expected, whereas, at the same time, expectations pertaining to *price variability* are revised each year.

In fact, it is easy to see that, given the risk aversion coefficient A (which can be held constant), a guess is necessary at σ_p^2, the variance of price for each producing activity. Here a 'naive' expectations scheme for variances has been defined which, with i as the activity index and t as time, is given as:

$$\sigma^2_{pi} = (P_{it-2} - P_{it-2})^2$$

RESULTS

Simulations were performed under various scenarios, as indicated above.[3] A summary of the numerous results thus obtained is presented in the figures below. In particular, there are a number of observation which can be made, which follow as brief comments on the figures.

The predicted growth path of consumption within the economy is considerably influenced by risk (Figures 1 and 2). In this respect, in both countries (although it is more visible for Poland than for Hungary), the 'no risk' solution is very much superior to the other three solutions. As in plain linear programming models, suppressing risk (should it be possible!) would play the same role as a huge dose of technical progress.

Risk considerations especially affect the quantity of agricultural production, through manpower availability, as suggested for Poland by Figures 3 and 4 (similar results apply to Hungary).

The consequences of risk for investment (and thus for future growth) are extremely important, as illustrated by Figures 5 and 6, which represent savings and investment in Hungary. One should note the high discrepancy between real investment and saving, as well as the fact that the discrepancy increases with

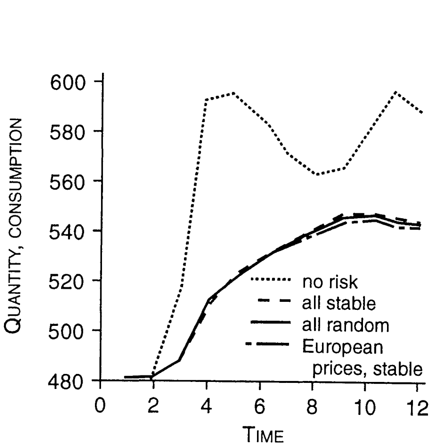

FIGURE 1 *Consumption in Poland*

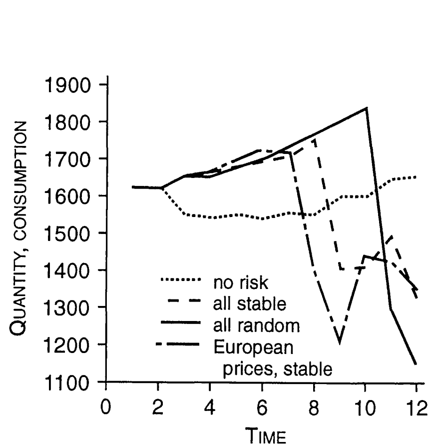

FIGURE 2 *Consumption in Hungary*

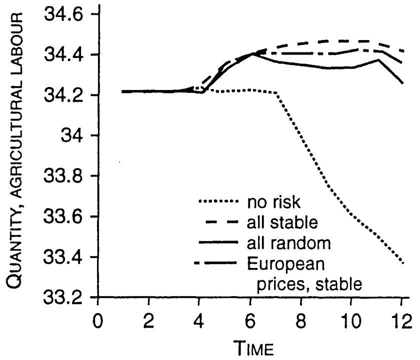

FIGURE 3 *Poland, agricultural labour*

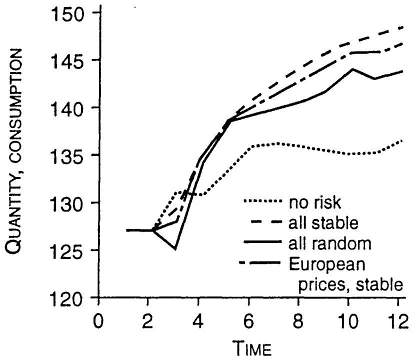

FIGURE 4 *Poland, agricultural production*

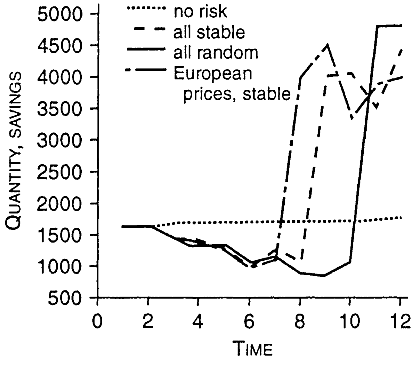

FIGURE 5 *Hungary, savings (volume)*

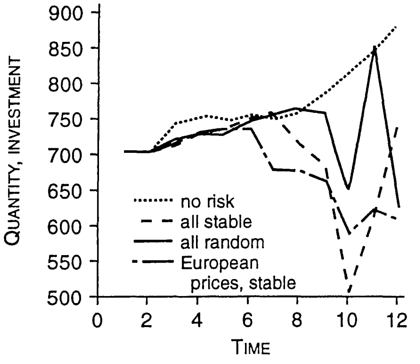

FIGURE 6 *Hungary, investment (volume)*

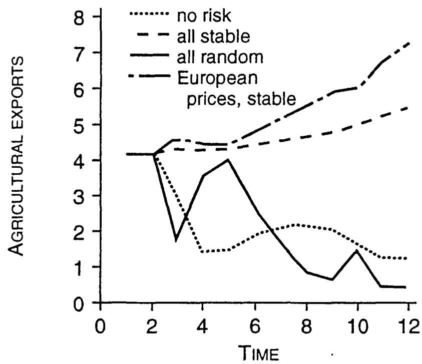

FIGURE 7 *Poland, agricultural exports to EU*

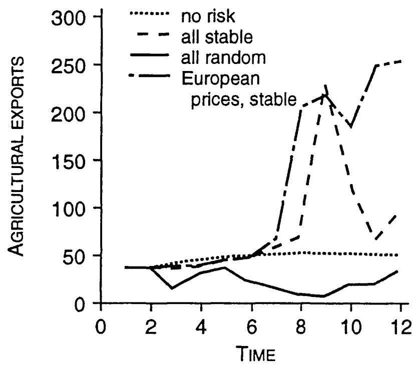

FIGURE 8 *Hungary, agricultural exports to EU*

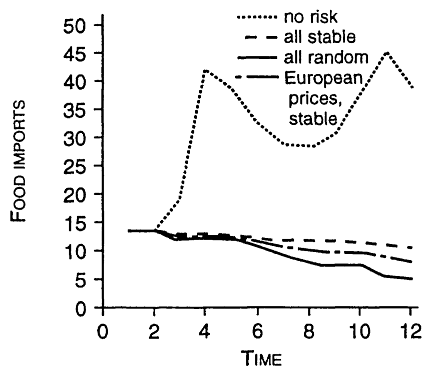

FIGURE 9 *Poland, food imports*

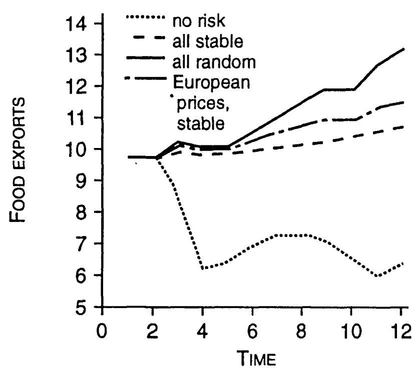

FIGURE 10 *Poland, food exports to EU*

risk. This is fully in accordance with the core of Keynesian theory (Shackle, 1965).

If we now turn our attention towards the various 'with risk' scenarios, the observed differences are smaller than expected. However, while this is true for growth in general, it is not the case when trade is considered. In particular, if the European Union remains as a buyer of agricultural products at fixed prices, while leaving the general level of world prices unstable, it could face an explosion of agricultural exports from Poland and Hungary, as shown in Figures 7 and 8. Note that, for different reasons, the same situation may occur if none of the foreign prices are fixed. In that case, the situation of the Polish and Hungarian economies is so bad that the resource transfer between agriculture and non-agriculture is difficult, resulting in an increase of agricultural production.

It must also be noted that what is true for agriculture is not necessarily true for food imports or exports, as shown in Figures 9 and 10, where Polish food imports and exports are displayed. Instability decreases food industry exports, and increases imports, in Poland, by comparison with 'no risk' situations. The same is true of Hungary, though that is not illustrated here. The precise mechanism in operation in these situations is not yet fully understood.

CONCLUSIONS

The results which have been obtained are only illustrative of what can be expected when risk considerations are explicitly introduced into general equilibrium models. They show that many optimistic statements about positive effects of trade liberalization may be far less justified than is commonly admitted. But they are only partial, and should be supported by additional experiments. In particular, the phenomena which have been observed here are much too dependent upon assumptions regarding foreign trade elasticities, which are obviously always disputable. A more general and comprehensive model at the world level, on roughly the OECD RUNS model format (as described, for instance, by Goldin and Knudsen, 1990), but modified along the lines described above, is now being considered.

NOTES

[1]The restriction to these two countries is caused more by data availability than anything else. It was extremely difficult to obtain social accounting matrices for countries such as Romania or Latvia. Many thanks are due to W. Orlowski (World Bank), who let us have access to Polish and Hungarian SAMs.

[2]The only exception is with the price ratio of agricultural labour against non-agricultural labour, as discussed above in the recursive definition of the population. Here, naive expectations ($^\wedge P_t = P_{t-1}$, with $^\wedge P_t$ standing for expectation in year t, and P_t, for the actually observed price in year t) are assumed, very naturally.

[3]Since results were thought to be sensitive to the elasticities of substitution used in the CES production functions, different sets of elasticities were investigated. Although slight differences were found in the results, they were not sufficiently significant to be presented. Only results with the 'high elasticities of substitution' set are mentioned.

REFERENCES

Boussard, J.M. (1996), 'When risk generates chaos', *Journal of Economic Behavior and Organisation*, **29**, 433–46.

de Janvry, A. and Sadoulet, E. (1995), *Quantitative Development Policy Analysis*, Baltimore: Johns Hopkins University Press.

Folmer, C., Keyzer, M., Merhis, M.D., Stolwijk, H.J.J. and Veenendaal, P.J.J. (1995), *The CAP beyond the McSharry Reform*, Amsterdam: North-Holland.

Goldin, I. and Knudsen, O. (1990), *Agricultural Trade Liberalisation: Implications for Developing Countries*, Paris: OECD.

Shackle, G.L.S. (1965), *A Sketch of Economic Theory*, Cambridge: Cambridge University Press.