CAUSES OF OUTPUT DECLINE IN ECONOMIC TRANSITION: THE CASE OF CENTRAL AND EASTERN EUROPEAN AGRICULTURE

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ABSTRACT

This paper quantifies the relative importance of the different causal factors of the changes in agricultural production in Central and Eastern Europe since 1989 using a production function and supply response approach. The analyses show that the deterioration of the agricultural terms of trade explains a considerable part (40 to 45 %) of the production change. The effects of the extreme weather conditions that coincided with the reforms explain 10 % to 20 % of the output decline, where as the transition uncertainty accounts for 10 % to 15 %. The shift of the production to family farms caused a productivity increase due to improved labor effort but the process of disruption of the production structures caused a (temporary) negative effect. The net effect of the restructuring was slightly positive. Privatization had a strong negative effect on the output. In Albania, Bulgaria and Romania this effect was due to declined technical eficiency. In contrast, factor productivity increases in the Czech Republic, Slovakia and Hungary completely offset this effect. The negative privatization effect in these countries was largely due to factor adjustment (mainly labor shedding), i.e. improvements in allocative efficiency. Finally, our analyses suggest that up to 25% of the output decline may be a statistical phenomenon.

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1. INTRODUCTION

Economic reforms in the Central and Eastern European economies (CEECs) have induced important output changes in agriculture since 1989. Figure 1 shows that gross agricultural output (GAO) has declined strongly between 1989 and 1992 in all CEECs included in this study (Albania, Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia, Slovenia). In Albania, Romania and Slovenia important output growth occurred since 1992. In the other CEECs, GAO decline continued until 1994. With the exception of Slovakia, GAO increased (slightly) in 1995. The difference between Albania and the other CEECs is quite remarkable, especially because the initial (1989-1991) decline was still under its communist regime. Since the start of the Albanian reforms in 1991 GAO has grown more than 11% annually on average (table 1). The difference in output change between crops and livestock is relatively small, except in Bulgaria and Romania where livestock output declined substantially more than crop production.

The reforms included price and trade liberalization, privatization, enterprise restructuring and macroeconomic reforms. The relative impact of these various policy reforms on the agricultural output changes is uncertain. Jackson and Swinnen (1995) conclude that the relative changes in CEEC agricultural output are caused by a combination of declining terms of trade following price and trade liberalizations, transition-related disturbances caused by property rights reforms and enterprise restructuring, and by extreme weather conditions in some years. They also suggest that part of the output decline may be a statistical phenomenon. Effective output is likely to be overreported in the pre-reform years, while the statistical coverage is likely to underestimate the actual output after the reforms.

The objective of this paper is to quantify the relative importance of these causal factors through an econometric study. The relative importance of the factors is important to understand, especially for the prediction and modeling of future output developments of CEEC agriculture. For example, if the decline is mostly due to the realignment of relative prices, then one can expect a strong recovery in case of future price increases, e.g. in the case of accession of the CEECs to the European Union (EU).

The methodology used in this paper follows Lin's (1992) analysis of the impact of Chinese economic reforms on agricultural growth. As Lin, we use both a production function model, in the tradition of Griliches (1963), and a supply response model to estimate the impact of various factors on output changes. The combination of both allows to estimate total impacts of institutional reforms, price realignments and technological factors on agricultural production. The models are estimated with annual data for eight CEECs.

The paper is organized as follows. The next section discusses CEEC economic reforms and their implementation. Section 3 summarizes the data. Section 4 and 5 present the production and supply function models and the results. Section 6 concludes.

2. ECONOMIC REFORMS AND CEEC AGRICULTURE

Reforms started in 1989 in Poland and soon afterwards in many CEECs. The latest was Albania, which only in 1991 implemented the first reforms. This section discusses three key parts of the reforms and some of their effects in the agri-food sector: the price and trade liberalization (including subsidy cuts), privatization and land reform, and farm restructuring.

2.1. Reform of price, trade and tax policies

Prices, production and trade were determined by the state, often reflecting political rather than economic objectives and causing inefficiencies in production, consumption and trade patterns. Price and trade liberalizations, including subsidy cuts, therefore induced important adjustments in relative prices, as well as hyperinflation, during the first years of transition. Figure 2 and 3 illustrate how the relative price adjustments and the most important inflation occurred during the first two years of transition in Poland – as in most CEECs included in this analysis.

After price and trade liberalization and subsidy cuts, consumer prices soared, real incomes often declined, and domestic demand fell. In addition, foreign market access had been reduced as the traditional agricultural export markets in the former Soviet Union dwindled because of lack of hard currency and because the Western countries remained closed for CEEC agricultural exports. At the same time input prices for agriculture increased strongly relative to producer prices (figure 3). The resulting deterioration of agricultural terms of trade was considerable in all countries, and most extreme in Romania and Poland. In Slovakia, the fall in relative prices seems to have been less severe than in the other countries. Figure 3 shows how the relative prices in Poland have been fairly stable since the first two years of transition.[1]

2.2. Privatization and land reform

Land reforms, and privatization in general, in CEEC agriculture have important effects on efficiency and on income distribution. In the case of CEEC land reforms, the distributional effects include two separate issues: the social ("equity") considerations of the reforms and the legal ("historical justice") demands of pre-collectivization land owners whose land was confiscated by the communist regime or who were forced to participate in the collectivization.

Restitution of collective farm land to former owners and sale of state farm land are the most common forms of land privatization in CEECs. An important share of collective farm land has been returned to former owners in the majority of CEECs in this study (see table 2). Typically, land was returned to former owners using historical boundaries where possible. Otherwise, former owners were given property rights to a plot of land of comparable size and quality. The main exceptions to the restitution of collective farm land are the sale (for compenzation bonds) of two-thirds of the land used by Hungarian cooperatives, the land distribution in kind to the rural population in Albania, and the land distribution in shares in Russia and Ukraine.[2] In the majority of CEECs, state farm land is to be sold. The land is leased until sales are implemented. For example, in East Germany nationalized land is managed by the "Land Utilization and Administration Company" and leased to former owners and to legal entities.

Land redistribution programs typically have five stages: (1) claims are submitted; (2) ownership certificates are issued, indicating the rightful claim of the person or family to an asset; (3) the precise value of the asset is calculated and/or land parcels are redrawn and the

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[1] These price adjustments caused political pressure for CEEC governments to re-introduce policies to support agricultural producers and/or food consumers. This occurred in two phases: first in an ad hoc way and later, as the CEEC governments gained familiarity with the functioning of a market economy, they moved to formulating a comprehensive set of agricultural policies, including in some cases guaranteed prices, production quotas, (variable) export subsidies and import levies. This re-emergence of interventionist policies in the CEEC agro-food sector is primarily driven by domestic political economy factors and differs strongly between CEECs (Swinnen, 1996).

[2] The main determinants behind these land reform choices are: (1) the post-collectivization legal ownership, (2) ethnic factors, (3) pre-collectivization land distribution, and (4) efficiency considerations (Swinnen, 1997b).

precise land parcel identified; (4) surveys are completed; and (5) land titles are issued. The uncertainty on property rights is only solved by finalizing the fifth step; issuing the land titles.

Commissions and agencies have been created in all CEECs to implement the agricultural privatization and land reform program. In former Czechoslovakia, each cooperative and state farm has elected a transformation board to handle the privatization of the farm. The management of Bulgarian collective farms was replaced with a Liquidation Council, responsible for the privatization of farm assets and the management of the farms during the transition. Under the land restitution program, the claims of land ownership are handled by municipal land councils. Romania has similar commissions in each village to redraw the maps and allocate the land among claimants. In many instances the members of these councils represented collective farm interests – which were opposed to farm disruptions and land restitution. The inherent transaction costs and asymmetric information in reform implementation has allowed local agents to manipulate the reform implementation and limit the transfer of effective property rights.

In many CEECs these developments have been enforced by additional land reform legislation – often implemented under pressure of collective farm members and supported by former Communist Parties – to limit the rights of new owners to use and transfer the land. For example, Slovenia has introduced the concept of "co-ownership of land" to give the former state farms security of operation during an "adjustment period" of several years in which the state farms can continue their operation on land destined for restitution without fear of being disrupted.

Table 3 shows that more than 80% of agricultural land was in private ownership by 1995, except for Bulgaria. The progress during the first years of transition differed quite strongly between CEECs. In many CEECs, local opposition slowed down the reform implementation, but progress was also slow because of technical and legal complexities. For example, Hungary's reforms have been slowed considerably by the introduction of additional compenzation laws after the start of the reforms. Still, the slow progress in Poland, Hungary and the Czech Republic has resulted in amendments to the original laws to speed up the process and penalize opposition. On the other hand, Romania and Albania started fairly late, but a fast and widespread "spontaneous privatization" has resulted in a quick *de facto* large private agricultural sector.

A slow privatization process prolongs the uncertainty of property rights. As long as property rights are uncertain, decapitalization of agriculture continues through the liquidation of productive assets, including the slaughtering of livestock, and a reduction of investment and maintenance. Since land titles have not been assigned, a land market cannot emerge and producers cannot obtain credit for purchasing basic inputs. With low overall profitability in farming, the poorly developed banking system refuses to lend to agricultural producers without collateral, negatively affecting agricultural output.

2.3. Farm restructuring

Large-scale collective and state farms were inefficient organizations because they reflected suboptimal factor allocations and incorporated poor incentive structures. Farm restructuring therefore includes both a reallocation of production factors (land, labor and capital) and an organizational reform (e.g. from cooperative and state farm to family farms or to a joint stock company). In general, the emerging farm structure is determined by the privatization and land reform process, and other economic, political and institutional factors. Economic factors include the impact of transition risk and uncertainty, and negative terms-of-trade developments. A key political factor is the use of decollectivization and land restitution to create an anti-communist political base of small property owners in the rural areas.

Most CEECs have now a mix of "private" cooperative farms, joint-stock companies, family farms and part-time farmers. However, table 4 shows how this mix varies between CEECs. The current farm structure ranges from virtually all individual farms (smaller than 5 hectares) in Albania to virtually all large-scale cooperatives and farming companies of more than 100 hectares in Slovakia. The latter is more typical of the region, because even in Romania, where very small farms occupy around 60% of the land, there is still a substantial number of large-scale farms (OECD, 1996). In Poland and Slovenia no important restructuring or privatization occurred, as agricultural production was already mainly located on individual farms in private ownership, prior to the reform.

The break-up of the collective farms is substantially higher in CEECs where an important share of the land was distributed to farm workers (Albania and Romania) instead of returned to former owners. In comparison with other procedures, distribution of farm land to workers reduces the transaction costs of renting or selling land and other assets for individuals wanting to leave the collective farms. Further, government policies differ in the incentives or hurdles they have created for individual farming. Another important factor determining the emerging farm structure is the average productivity and technology use on collective farms. Individuals were more reluctant to leave the large scale farms in countries where the collective farms were most productive and least labor intensive. There is a negative correlation between the break-up of collective farms into family farms and the pre-reform average productivity of the collective farms (Mathijs and Swinnen, 1996).

Comparing tables 1 and 4 yields the striking observation that the CEECs with the most dramatic disruption in the farm structure have realized the strongest growth in agricultural production. Figure 4 shows a remarkable correlation between the average annual change in crop output and the relative increase in the use of agricultural land by individual farms (as measured by Mathijs and Swinnen's "decollectivization index"). For example, Albanian agricultural output increased sharply every year since the beginning of its reforms and Romania has positive agricultural output growth since 1993. In contrast, gross agricultural output in Hungary and Slovakia continued to fall and only leveled out in 1995.

Our further analysis will show that this observation is caused by a combination of factors, including stronger efficiency improvements in labor intensive production systems with improved labor effort in family farms, but also because of differences in pre-reform productivity and factor reallocations during transition. In Hungary, the Czech Republic and Slovakia, output has fallen stronger in absolute terms, but farm restructuring has induced more labor shedding and thereby also important productivity improvements.

3. DATA

We use the same approach as Lin (1992) who analyzed the impact of Chinese reform on agricultural output and productivity. As Lin, we apply a production function model and a supply response function model to aggregate (sector-level) data. The different causal factors can influence production by inducing changes in input use, or by causing changes in productivity. With the production function model, we can identify the factors that influence productivity. The supply response function model allows us to indicate all causal factors, the ones that have an impact on productivity as well as the ones that influence the use of production factors. By comparing the two models, we can not only determine which factors caused the output changes, but also how this occurred.

The data used in this study includes observations from seven transition years (1989-1995) and eight countries in Central and Eastern Europe: Albania, Bulgaria, the Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia. A number of adjustments were required in order to make the data suitable for this study. Detailed information on sources and adjustments is given in the appendix. Here we only report a summary description of the dataset.

As in Lin's (1992) study, our analysis is limited to the crop sector. There are two reasons for this. First, the quality of the data to calculate the right hand side variables is considerably better for crops. Second, because of the structure of the industry and the production system, animal production is likely to respond with a (much) larger lag period than crops, where an important output reaction can occur within a one year production cycle. For this reason, seven years of data appear insufficient to analyze the determinants of the changes in animal production.

The independent variable, OUTPUT, is measured as the total annual value of 5 crops – wheat, maize, barley, sugar beet and oilseeds (rapeseed and sunflowerseed) – aggregated with the same international prices for all CEECs. There are important differences in the evolution of the aggregate crop output between the CEECs. The output fall was strongest in Hungary, where crop output was reduced to 56% in 1993 and in Bulgaria, with a fall in 1993 to 62% of the 1989 level. Czech crop output declined less. Although the fall in Romania was considerable, there was a strong recovery after 1992 and in 1995 Romania was the only country were crop output exceeded the 1989 level. Albania is an exception, with a strong decline prior to the reforms in 1991. After the implementation of the reforms output started to rise, an evolution which contrasts with the experiences in the other countries. It should be added that in Albania a clear shift to animal production occurred, an evolution that started already before the reforms. Due to this shift, the growth of GAO in figure 1 is larger than the growth of crop production.

For the conventional inputs, we used the same specifications as Lin (1992), which corresponds to the standard specification of an aggregate agricultural production function. The indicator for capital (CAPITAL) is measured as the total amount of tractor horsepower in use. LABOR measures the number of workers in crop production. LAND is the total number of hectares used for the crops included in the analysis. FERTILIZER is measured in tons pure nutrient of chemical fertilizer. Hayami and Ruttan (1970) pointed out that capital and fertilizer should be interpreted as proxies for advanced agricultural technologies, mechanical as well as chemical/biological.

General trends are that land use remained rather constant (with only a considerable reduction in Albania) and that fertilizer input declined dramatically (figure 5). Machinery input declined substantially in most countries, except for Poland and Romania. The main difference in input developments is in labor use. A large reduction of labor input occurred in Hungary, Czech Republic, Poland and Slovakia; In contrast, labor input increased in Romania, Bulgaria and also in Slovenia. In Albania, part of the reduction of labor in the crop sector is due to an important shift to animal production. This shift also explains a part of the reduction of land input.

In addition to the conventional inputs, other factors are included to reflect various processes occurring during the transition. These other variables are used to capture the effect of farm restructuring (IND), disruption (DISR), privatization (PR), uncertainty (UNC) and relative price changes (PP/IP). A weather variable (WEATHER) is added to capture the effect on output of changes in weather conditions. These variables are discussed in the next sections, together with their expected effects in both models.

4. PRODUCTION FUNCTION MODEL

The estimation of a time-series cross-country production function is based on the assumption that there exists a common meta-production function for the eight countries. The term “meta-production function” was first introduced by Hayami and Ruttan (1970) denoting the envelope of several production functions of a group of countries. By using this concept, one does not assume that individual producers in different countries are on the same micro-production function, but that all countries have access to the same technology. The techniques that are actually implemented depend on the physical environment and available resources (Mundlak and Hellinghausen, 1982).

Although the use of one aggregate production function for different countries may seem a bit controversial, empirical results of several studies confirm its existence and support its use for cross-country analysis (Hayami and Ruttan, 1985; Bhattacharjee, 1955; Nguyen, 1979). Most of these estimations of meta-production functions use observations of totally different countries in different parts of the world. Furthermore two studies have successfully estimated a meta-production function for nine socialist countries, including several CEECs (Carter and Zhang, 1994; Wong, 1986).

The studies used different functional forms for estimating the meta-production function. In spite of the well-known limitations of the Cobb-Douglas specification, it is the most commonly used function in these studies and the studies that applied it obtained good results. Therefore our analysis also uses a Cobb-Douglas specification of the agricultural production function.[3] Two additional arguments are our limited number of observations and that it allows to compare our estimates of input-output elasticities with respect to each input with the other studies.

The amount of output generated with a certain amount of inputs depends on the intensity and quality of input use. For example, workers react on incentives, created by the institutional and economic environment, by changing their labor effort and thus the intensity of the production factors (Leibenstein, 1966; Carter, 1984). To account for the different factors that affect productivity, different production function shifters are included in the model. The specification of the production function is

$$\ln(OUTPUT_{it}) = \alpha_0 + \alpha_1 \ln(CAPITAL_{it}) + \alpha_2 \ln(LABOR_{it}) + \alpha_3 \ln(FERT_{it}) + \alpha_4 \ln(LAND_{it}) + \alpha_5 IND_{it} + \alpha_6 DISR_{it} + (\alpha_7 + \beta\, CSH_i)\, PR_{it} + \alpha_8 UNC_{it} + \varepsilon_{it}$$

where i refers to country, t to year. The α’s and β are the coefficients to estimate and ε_{it} is the error term. The production function has four conventional inputs: capital, labor, fertilizer and land (see previous section). In addition, four other variables are included to capture the effect of farm restructuring (IND), disruption (DISR), privatization (PR) and uncertainty (UNC). The impact of the weather on crop output is captured by the conventional inputs, due to the way these are defined in our model. Therefore, a weather variable is explicitly included in the supply response model but not in the production function model.

The *individual farm variable (IND)* is measured as the change in the share of total agricultural land used by individual farms (family farms). This is used as a proxy for the increase in the agricultural working force in individual or family farms and reflects the impact of labor effort on output.[4]

[3] A translog specification of the production function was also tried, but gave no reasonable results.
[4] Lin (1993) uses the share of households in individual farms to account for the change in labor effort.

Due to monitoring problems, the incentive to work in a cooperative farm is lower than in an individual farm (Lin, 1993; Schmitt, 1993). The change of agricultural production from collective farms to individual farms is therefore expected to increase the incentives for labor effort. Individuals will increase their labor efforts, as their income will now be directly related with the performance of the farm. This causes an increase in the productivity of the labor hours as well as in the intensity with which the other inputs are used (Carter, 1984). In a production function framework, this means a shift towards the frontier and an increase in technical efficiency. For this reason, the break-up of collective and state farms into individually managed farms ("decollectivization") is expected to have a positive effect on output. Decollectivization had a considerable impact on technical efficiency in China (Mc Millan et al., 1989; Lin, 1992; Kalirajan et al., 1996) and Vietnam (Pingali and Xuan, 1992).

The *disruption variable, DISR,* is the percentage of agricultural land that has been involved in restructuring to individual farms in the year of the observation and the year before. The break-up of production structures is expected to temporarily disrupt production due to imperfect functioning of markets, causing a reduction in allocative efficiency. The adaptation of capital inputs to production on smaller scale occurs with a lag, which is worsened by the general shortage of credit for agriculture in transition economies. This proved to be a major constraint on farm restructuring and production in CEECs (Swinnen, 1995). The slow development of land markets also prevents an optimal allocation of land.

Furthermore, also technical efficiency is likely to decrease. In a study of overall output decline in Poland, Roberts (1995) pointed out that disruption may cause a temporary inward shift in the production function inducing a considerable decline in output. Due to the break-up of production structures, some inputs are not used at full capacity. The existing machinery for example, might be inappropriate for the newly established smaller scale farms and stay idle for some time. Restructuring will thus have a negative impact on output due to temporary allocative and technical inefficiency. These effects are most important during the first years after the break-up.

The *privatization variable, PR,* measures the change in the share of privately owned land. Privatization induces a shift of incentives towards profit-maximizing, as it coincides with a shift from a soft to a hard budget constraint. The hard budget constraint induces a reallocation of production factors with resources flowing out of agriculture (Brooks, 1991). Privatization thus improves allocative efficiency. In a production function approach, this means a move along the production function. Output declines, due to a correction of the distorted pre-reform situation with excess use of agricultural inputs. [5]

There was excess employment in the whole economy, prior to the reforms, which pushed production levels higher than profitable (Brada 1989; Bofinger, 1993). According to Jackman (1994), agriculture was one of the sectors were the employment level was most out of line with the general pattern in market economies. Everything else equal, the amount of labor input will thus decrease with privatization, to correct for the excess supply of labor. However, this is only possible if the management has the autonomy to decide about the shedding of labor. Marek and Lehmann (1992) indicated that Polish managers in state enterprises have been weak to make employment decisions, as workers had considerable power when it came to firing employees. If shedding of excess labor takes place, privatization is expected to induce a labor productivity increase.

However, if the prices of other inputs increase substantially relative to wages in agriculture (or if other inputs are not available), the labor force might increase, due to a

[5] Wong (1986) found serious misallocation of resources for nine socialist countries, including most of the countries in our data-set.

substitution effect. Low opportunity costs of labor as e.g. in Romania may lead to the same result. Thus even when privatization induces profit-maximizing behavior by autonomous managers, labor input may increase when wages decline relative to other input prices. In this case, labor productivity will decrease.

Carter (1984) points out that property rights not only affect resource allocation, but also the intensity of resource utilization. In his study on Peru, he found that technical efficiency was significantly smaller in labor-managed farms than in private farms. In the case of collective ownership, the authority to supervise labor and control free-rider problems is likely to be weaker and thus effort will be smaller. Labor-managed firms lack unidirectional lines of authority to collect information and enforce rules. Therefore, privatization might also increase technical efficiency. However, this is only likely if the management is indeed autonomous from the workers.

CSH is a slope dummy on the privatization variable (PR) for the Czech Republic, Slovakia and Hungary to capture some of these constraints. Recall that in Poland and Slovenia privatization was much less important, as private farms were already the main form of agricultural production prior to the reform. Therefore, the slope dummy CSH measures a difference in the response to privatization in the Czech Republic, Slovakia and Hungary in comparison with Romania, Bulgaria and Albania. Both the autonomy of management in making labor reallocation decisions and labor opportunity costs differ markedly between these groups of countries.

First, the agriculture in the Czech Republic, Slovakia and Hungary accounts for a smaller share in GDP and employment (table 5). Schiff and Montenegro (1997) show that the supply of input factors is less elastic in countries were agriculture accounts for a larger share in total economy and that the aggregate output response is negatively correlated with the share of agriculture in GDP. Therefore, output responses in the Czech Republic, Slovakia and Hungary are likely to be larger as the larger mobility of the production factors, notably labor, allows a quicker adaptation to the changed situations. As workers perceive the shedding of excess labor, they are likely to increase their labor efforts, and thus technical efficiency. On the other hand, if there is less outflow of excess labor out of agriculture due to lower opportunity costs of labor as in Romania and Albania, real wages will decline in a profit-maximizing circumstances. This might have a negative effect on the incentives of the workers and thus induce a decrease in technical efficiency.

Second, in the Czech Republic, Slovakia and Hungary, property rights of land and use of land are probably more separated. The cooperatives in these countries mainly work with hired labor, which means that the management has supervisory authority and is able to take autonomous decisions, which has a positive impact on the effort of the workers. In the other countries, workers in the remaining large scale farms are more likely to be owners of most of the land of the farm. Therefore, it is more likely that management lacks the authority to fire workers. Nevertheless, the management (or the head of a family farm) faces a strict budget constraint due to privatization. As expenses can not be cut by reducing the number of workers, this could bring about a reduction of the wages and therefore a reduction in technical efficiency.

Finally, Jackson and Swinnen (1995) indicate that privatization could also change incentives for output reporting. If so, in the production function model, this will be reflected in a decrease of the technical efficiency, because with the same amount of inputs, less output will be recorded.

A *dummy variable, UNC,* is included to measure the impact of uncertainty. During the years of major policy changes it takes value 1, in the other years it takes value 0. As Cochrane

(1955) argues, the cost of bearing risk by farmers has the effect of increasing marginal costs and thus reduces supply by reducing inputs.

Both the dependent and the independent variables that are in log-linear form in the production function are normalized around their 1989 value. As the log of an index equals the difference of the logs, the specification of the other variables is such that they also give the difference between the value in year t and the 1989 value. IND is defined as the difference between the share of land in individual farms in year t and 1989 and PR as the difference between the share of private owned land in year t and 1989. DISR and UNC automatically reflect the difference as they take value 0 in 1989.

By normalizing around the 1989 value we eliminate problems of heteroscedasticity. Furthermore, we reduce possible measurement biases due to different statistical methods in the different countries or due to omitted country specific variables like climate or soil quality. The specification of all variables as differences still allows us to interpret the coefficients of the production factors as output elasticities. Hatziprokopiou et al. (1996) used the same normalizing method in a production function estimation.

The production function was estimated with annual data from Albania, Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia between 1989 to 1994.[6] For Slovenia data are missing for 1994. The least squares estimation results are reported in table 6. The coefficients of the production factors are all between 0 and 1 as the Cobb-Douglas specification requires (declining marginal products). The coefficients for fertilizer (0.15), labor (0.26) and capital (0.30) are comparable with the coefficients found in other time series cross-country estimations.[7] The coefficient for land (0.53) is higher than in most studies. However it is similar to production function estimations for crop production only, such as Lin (1992) and Carter (1984). This is consistent with the fact that land is an important and limiting production factor for crop output, more than for total agricultural output.

The signs of the coefficients of the restructuring into family farms, IND (+0.006) and the disruption variable, DISR, (-0.007) are consistent with our expectations. The break-up of collective and state farms into family farms stimulates output as it increases labor effort, but at the same time, the temporary production disruptions caused by this restructuring process reduces output.

The negative coefficient of PR (-0.0039) indicates a negative effect of the privatization, but the coefficient of the slope dummy CSH is positive (+0.0077) and larger in absolute value than the PR coeffcient. This means that privatization in the Czech Republic, Slovakia and Hungary had a positive effect on technical efficiency, opposite to the negative effect in the other countries. These results are consistent with the hypotheses formulated above. Privatization induced an important reduction in labor input in the Czech Republic, Slovakia and Hungary through a combination of voluntary labor adjustments, lay-offs and retirement as alternative employment opportunities, unemployment benefits and pension schemes were better than in Albania, Bulgaria and Romania. As a result, the effects on labor productivity are opposite in both groups of countries (see also fig.6).

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[6] For the estimation of the supply function observations for 1995 were also included, but 1995 data for some inputs in the production function were missing.

[7] Comparing results of cross-country studies that follow the Hayami-Ruttan approach, the coefficient for capital (machinery and livestock) ranges from 0.064 to 0.476, the coefficient for labor ranges from 0.082 to 0.533 and the coefficient of fertilizer ranges from 0.128 to 0.270. Our results fall between these ranges. (Bhattacharjee, 1955; Hayami-Ruttan, 1970; Nguyen, 1979; Mundlak and Hellinghausen, 1982; Kawagoe et al. 1985; Lau and Yotopoulus, 1989; Wong, 1986; Carter and Zhang, 1994)

The impact of uncertainty (UNC) is not significant. This conclusion does not depend on interaction or correlation with other variables, because removing UNC from the model has little impact and the estimations of the other variables' coefficients change little (compare column (1) and (2)). This result suggest that uncertainty does not affect technical efficiency.

5. SUPPLY FUNCTION

With the production function we were able to indicate the effect of factors that affect output through a change in technical efficiency. However, also the causal factors for the change in inputs, accounted for in the production function, can be identified. The estimation of a supply function allows to quantify the impact of producer price and input price changes on output changes. Furthermore the importance of factors that affect allocative efficiency as well as technical efficiency can be quantified.

5.1. Base model

The specification of the supply function model is

$$\ln(OUTPUT_{it}) = \alpha_0 + \alpha_1 \ln((PP/IP)_{it-1}) + \alpha_2 \ln(WEATHER_{it}) + \alpha_3 IND_{it} + \alpha_4 DISR_{it} + (\alpha_5 + \beta CSH_i)\, PR_{it} + \alpha_6 UNC_{it} + \varepsilon_{it}$$

where i refers to country, t to year, the α's and β are the coefficients to estimate and ε_{it} is the error term. The specification for IND, DISR, PR and UNC is the same as in the production function model. As in the production function model, the dependent variable is normalized around the 1989 value, as well as the price and the weather variables (PP, IP and WEATHER).

The *relative price index, PP/IP* is the ratio of producer prices to input prices and measures the agricultural terms of trade faced by the farmers. PP measures the evolution of the commodity prices since 1989. IP measures the evolution of the input prices since 1989. Theoretically, the relevant price variables should be the expected prices. Since no information about the structure of market-price expectations is available, we used the prices of the previous year, as is often done for aggregate supply estimations (e.g. Lin, 1992; Tweeten and Quance, 1969).

WEATHER measures the rainfall in year t rainfall during the crucial months for crop production (as in Herdt, 1970) and is expected to be positively related to output. CEECs have experienced several years of low rainfall during transition, which was argued to have substantially reduced crop production in these years.

The 46 observations used for the estimation of the supply function are from the years 1989 to 1995 for the countries Bulgaria, the Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia. In contrast to the production function model, Albania is not included due to a lack of price data. Also observations for Slovenia for the years 1989, 1994 and 1995 are missing.

The estimation results are reported in table 5. The coefficients of all the variables have the expected sign. Changes in prices clearly had a significant and an important impact on changes in crop output in CEECs. In previous estimations of aggregate agricultural supply response, the effect of agricultural terms of trade on output varied between a very broad range of 0.10 to 1.66. A number of time-series studies indicate a low aggregate supply response, such as Griliches (1960) for the US agriculture with a price elasticity of 0.15 and Herdt (1970) for crop production in the Punjab region in India with elasticity in the range of 0.10 to 0.20.

Peterson (1979 and 1988) found considerable higher aggregate elasticities for agricultural supply in cross-country studies (within a range of 0.90 to 1.66). He argues that estimations based on time series of one land inherently underestimate the supply elasticity.[8] Binswanger et al. (1987) used a time-series cross-country approach to estimate aggregate elasticity, taking several supply shifters into account. However, they obtained implausible negative supply response for aggregate, crop and animal output. According to them, this was due to the fact that all the variation was captured by a country specific variable and the supply shifters. As we used index numbers[9] in our time-series cross-country estimation, we eliminated the country specific factors, other than the ones accounted for in the model. The obtained price elasticity of 0.23 lies in the range of previous estimations. In the CEECs the rigidity of the production factors apparently was not restrictive to output response, during a price decreasing phase. There were large adaptation of the input of machinery, labor and fertilizer as we have explained in previous sections.[10] The estimation also shows that crop production during the transition years was significantly higher with higher rainfall and that uncertainty during the years of major policy changes reduces output. Compairing with the production function suggests that uncertainty mainly induces a change in inputs rather than a change in technical efficiency.

The positive coefficient for the individual farm variable, IND (+0.008) and the negative one for the disruption variable, DISR (-0.011) confirm the outcome of the production function estimation. The more negative coefficient of DISR in the supply response function estimation than in the production function estimation suggests that the disruption of the production structures also had an effect on allocative efficiency.

The negative sign of the coefficient of PR (-0.003) indicates that privatization had a negative impact on output. Again, the coefficient of the slope dummy CSH (+0.002) indicates that for the Czech Republic, Slovakia and Hungary, the privatization impact is less negative than in the other countries.[11] If we compare the results of the production function and the supply response function, we note that the coefficient of CSH is clearly smaller in the last one. This result suggests that privatization in these three countries induced both an improvement of technical and of allocative efficiency, and thus affects output in two opposite directions. The improvement of the technical efficiency (especially labor productivity) has a positive impact on output, while the improvement of the allocative efficiency (reduction in labor input) decreases the output, due to a correction of the former excess use of production factors.

As the coefficient of PR is approximately the same in the two models, it seems that privatization induced no improvement of allocative efficiency in the other countries. As we have explained before, this is probably due to weaker mobility of production factors in these countries, where agriculture accounts for a large share in GNP and employment, and to a less autonomous management in the remaining large scale farms. The substantial difference in changes in efficiency and labor productivity between on the one hand the Czech Republic,

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[8] The results of Peterson seem however to overestimate the response on price changes, as the price variables in his models capture also the effect of other supply response shifters (Rao, 1988).

[9] Tweeten and Quance (1969) also used index numbers for the estimation of aggregate supply of US agriculture.

[10] Output elasticities for individual countries and in the long run are likely considerably larger as many studies show that aggregate supply responses are lower than those of individual commodities (e.g. Cochrane, 1955; Binswanger, 1992; Singh and Tabatabai, 1992) and that short run elasticities are typically considerably lower than in the long run (Tweeten and Quance, 1969; Cavallo and Mundlak, 1982; Coeymans en Mundlak, 1993).

[11] In the supply response function, CSH indicates mainly the difference between the effects of privatization in the Czech Republic, Slovakia and Hungary on the one hand, and Bulgaria and Romania on the other hand, as Albania is not included in the supply response function estimation and as in Poland and Slovenia, almost no privatization occurred.

Slovakia and Hungary and on the other hand Bulgaria and Romania is clearly illustrated in figure 6. Labor productivity increased in the first group of countries due to a larger decrease in labor input than in production. In Bulgaria and Romania, the opposite occured.

5.2. Alternative specifications

Other specifications, presented in column (2) to (4) in table 7, test the robustness of the results, and more specifically whether interaction between some of the variables in the model influences the estimations. Column (2) shows the estimations of the supply function if Poland and Slovenia are also included in the slope dummy for privatization. Column (3) shows results if a time trend for the Czech Republic, Slovakia and Hungary (CSH) is included instead of the slope dummy. The model in column (4) does not include a variable for CSH differences. Several conclusions can be drawn.

First, there is no change in the sign of the coefficients in any of the specifications. This indicates that the conclusions about the direction in which the factors affect the output changes are reliable. Second, as expected, including Poland and Slovenia in the dummy has almost no impact on the estimations, as there occurred almost no privatization in Poland and Slovenia and therefore it is unlikely to have had any impact on output. Third, the estimated effects of relative prices (PP/IP), the weather (WEATHER), uncertainty (UNC) and disruption (DISR) are very robust and significant across the different model specifications: the relative price elasticity is 0.23 in all specifications; the weather coefficient varies between 0.30 to 0.32, the coefficient of disruption is 0.01 everywhere and the coefficient of UNC is between 0.04 and 0.05. The robustness of these results allows us to draw reliable conclusions on the quantitative effects on output of relative price changes, weather changes, the disruption and the uncertainty.

Fourth, the main effect of the alternative specifications is on the coefficients of privatization, which justifies the use of the slope dummy on PR. However, also the coefficient of the shift of to individual farming (IND) changes, albeit to a smaller extent. This indicates that there is some interaction between privatization and the shift of the production to individual farms. The coefficient of IND grows bigger of we take into account the differences between the country groups (as in model (1) to (3) compared with model (4)). An explanation for this result is that the positive effect of the the break-up of collective farms into individual farms is larger in countries as Bulgaria, Romania (and also Albania) (ABR) than in the Czech Republic, Slovakia and Hungary (CSH). In the CSH, the technology and factor intensity is clearly different than in the ABR, as reflected in their man-land ratio in table 5. Because of high transaction costs in large-scale labor intensive agriculture, expected productivity gains from the break-up of large scale farming are therefore relatively larger in the ABR countries (Mathijs and Swinnen, 1996). This has caused a much more extensive break-up of the large scale farms into individual farms in the ABR countries (see table 4). Because of this interaction between the privatization and the individual farm variable, we should be careful in interpreting the relative importance of their impact. However, as the signs of the coefficients are unaltered in the four models, the direction of their effect is clear – as is the conclusion that different characteristics of the agricultural production system and the overall economy in the CSH versus the ABR have induced different output effects.

6. ACCOUNTING OF RELATIVE IMPACTS

We use the outcome of the production and supply function to assess the relative contributions of the various factors to changes in agricultural output since 1989 in Central and Eastern Europe. Table 8 reports the growth accounting based on the estimated coefficients of production function (2) in table 6. On average for the eight countries, output declined with 17.53% in the period 1989-1994. Table 9 reports the growth accounting based on the estimated coefficients of supply function (1) in table 7. On average for the seven countries, output declined with 15.00% in the period 1989-1995. As the accounting in table 8 and 9 was done with (partly) different data, the results are not totally comparable. It is important to check if the relative importance attained to restructuring and privatization are consistent between the accounting based on the two different models. Therefore, we used the estimated coefficients of table 6 and 7 to do the accounting for the same years (1989-1994) and countries (excluding Albania). Table 10 reports the results.

Table 8 indicates that the effects on output due to changes in productivity caused by restructuring and privatization offset each other, and that reductions in production factor use accounts for 82% of total output decline. The decline in fertilizer use alone accounts for 42%. As fertilizer is the most flexible production factor, this suggests that a rapid production recovery may result if terms of trade would improve in the future. However, we should be careful when interpreting these results based on the estimation of the production function, as they allow only a partial conclusion. The change in production factor use reflects a combination of causes, including terms of trade, weather and privatization impacts, and does not account - or at least not directly- for the changes in allocative efficiency.

The output change accounting in table 9 and 10 shows that the relative price changes are the most important causal factor. Deterioration of terms of trade explains 40% to 45% of the output decline. If output prices will increase in the future e.g. in the case of accession to the EU, one can expect a strong recovery of the output. Furthermore, in the long run, output reaction to price changes might be even larger than our results suggest, as long run price elasticities are typically larger than short run elasticities.

Droughts during transition in Central and Eastern Europe account for 10% - 20% of the average production decline. This part of the output fall is temporary. Another temporary effect is due to uncertainty during transition, which caused output to fall more than 10%.

Restructuring caused two offsetting effects: an output decline because of organizational and systemic disruptions, and an output increase due to increased productivity with the shift to a more efficient organization. The net effect was slightly positive (5%-15%), but both sub-effects were large. Production disruption accounts for 40% to 60% of the average output decline. At the same time the increase of labor effort due to the break-up of large-scale farms into family farms caused a production increase of 45% to 70%. The second effect more than offsetts the disruption effect in all our estimations, and the net effect was small but relatively stable. Furthermore, the contributions in both the supply and production function model where fairly close, which suggests that the restructuring has mainly affected technical efficiency. Finally, the disruption is a transition effect, while the improved efficiency is a permanent effect, which should increase production in the future when disruption impacts disappear.

Our estimates indicate a large negative impact of privatization on agricultural output in all countries, but with considerable differences between the Czech Republic, Slovakia and Hungary (CSH) on the one hand (-15% to -20%) and Albania, Bulgaria and Romania (ABR) on the other hand (-35% to -45%). In addition, the reasons for the output fall are different. Comparison of the production and the supply function results shows that the decline in output in ABR is almost uniquely due to a decline in total factor productivity or technical efficiency (reflected in the approximately -40% contribution to output change in both models in table 10), while total factor productivity in CSH increased (4% in table 10). The -15% privatization effect on output decline in CSH is caused by a decline in factor input in those countries (captured by the production factors in the production function model), i.e. by an improvement in allocative efficiency, which more than offset the effects of the productivity increase. These strikingly different labor productivity effects are illustrated in figure 5. The reason for the important negative impact of privatization on technical efficiency are a combination of statistical effects (increased underreporting with privatization), decreased labor efforts with real wage declines with low alternative opportunities, and suboptimal factor allocation with organizational constraints on the remaining large scale farms in Bulgaria and Romania (see discussion above).

Finally, tables 8 to 10 show that the output decline that can be explained by the two models, is smaller than the measured output decline, as the part explained by the residual is negative. This is consistent with the argument of Jackson and Swinnen (1995) that the real output decline was overestimated by existing statistics. The residual (which varies between 5% and 25%) is therefore an indicator for the share of the output decline that is just a statistical phenomenon.

As on the one hand the results of the production function and the supply response function confirm each other, and as on the other hand the different specifications of the supply response function confirm the estimation, we can conclude that the analyses gives robust results. Therefor comparing the results of table 8, 9 and 10 allows us to draw reliable conclusions. The first important outcome is that relative price changes explain 40 % to 45 % of the output changes. Furthermore, extreme weather conditions account for 10 % to 20 % of the output changes and the uncertainty induced by the reforms, 10 % to 15 %. The net effect of the restructuring was slightly positive and therefor output fall was 5 % to 15 % smaller than would have been the case without restructuring. The shift to profit-maximizing due to privatization had on the other hand a strong negative effect on the output and explains 35 % to 45 % of the decline, except in the Czech Republic, Hungary and Slovakia where the negative effect was partially offset by a productivity increase. On average, privatization accounts for 25 % to 35 % of the total output effect. Furthermore it is important to note that the reduction in fertilizer input alone explains already almost half of the output change.[12]

[12] The reduction in fertilizer use can by a reaction on changes in relative prices, the weather and/or the privatization , as it appeared that these factors influence the level of the production factors.

CONCLUSION

Important changes in agricultural production have occurred in Central and Eastern Europe since 1989. All countries experienced a decline but there are important differences to note between the countries in the magnitude and the period of the decline. Different factors have affected the output changes: structural factors, such as the fall of the relative prices following price- and trade liberalizations and privatization; temporary factors, such as reform disruption and uncertainty; but also extreme weather conditions. The relative importance of these causal factors is important to understand, especially for the prediction and modeling of future output developments of CEEC agriculture. This paper has quantified the relative importance of the different causal factors. A production function estimation indicates the factors that had an impact on productivity. A supply response function allows to identify all the factors that influenced production. By comparing the result of the two models, it was possible to conclude which factors had an impact and how these factors influenced the production changes.

The analyses show that the deterioration of the agricultural terms of trade explains a considerable part (40 to 45 %) of the production change. The effects of the extreme weather conditions that coincided with the reforms explain 10 % to 20 % of the output decline, where as the transition uncertainty accounts for 10 % to 15 %. The farm restructuring influenced production in two ways. The shift of the production to family farms caused a productivity increase due to improved labor effort but the process of disruption of the production structures caused a (temporary) negative effect. The net effect of the restructuring was slightly positive. Privatization had a strong negative effect on the output. In Albania, Bulgaria and Romania this effect was due to declined technical eficiency – as measured by official data. In contrast, factor productivity increases in the Czech Republic, Slovakia and Hungary completely offset this effect. The negative privatization effect in these countries was largely due to factor adjustment (mainly labor shedding), i.e. improvements in allocative efficiency. Finally, our analyses suggest that up to 25% of the output decline may be a statistical phenomenon.

When considering further evolutions of the production in CEECs, it is important to distinguish between factors that caused a temporary production decline, such as the weather, the uncertainty and the disruption, and structural factors such as relative price changes, privatization and farm restructuring on the other hand. This paper shows that the relative prices played a crucial role in the output changes in the CEECs. If an increase of the relative prices would occur, e.g. in the case of integration of the CEECs in the European Union, an important output increase is to be expected.

REFERENCES

Bhattacharjee, J.P., 1955, “Resource Use and Productivity in World Agriculture”, *Journal of Farm Economics,* 37(1), pp.57-71.

Binswanger, H.P., M-C. Yang, A. Bowers and Y. Mundlak, 1987, “On the Determinants of Cross-country Aggregate Agricultural Supply”, *Journal of Econometrics,* 36 (1/2), pp. 111-131.

Binswanger, H.P., 1994, “Determinants of Agricultural Supply and Adjustment Policies” in Heidhues F. and B. Knerr (eds), *Food and Agricultural Policies under Structural Adjustment*, Seminar of the European Association of Agricultural Economists, Hohenheim 1992, Peter Lang Europaïscher Verlag der Wissenschaften, Frankfurt am Main, pp. 107-136.

Bofinger, P., 1993, “The Output Decline in Central and Eastern Europe: A Classical Explanation”, Centre for Eonomic Policy Research, *Discussion Paper Series*, London.

Bojnec, S., W. Münch and J. Swinnen, 1997, “Exchange Rates and the Measurement of Agricultural Price Distortions in CEECs and of CEEC-EU Accession Costs”, unpublished draft.

Brada, J.C., 1989, “Technical Progress and Factor Utilization in Eastern European Economic Growth”, *Economica*, 56, pp. 433-448.

Brooks, K.M., 1991, “Decollectivization and the Agricultural Transition in Eastern and Central Europe”, *Policy, Research, and External Affairs Working Papers,* The World Bank.

Brooks, K.M., J.L. Guasch, A. Braverman and C. Csaki, 1991, “Agriculture and the Transition to the Market”, *Journal of Economic Perspectives,* 5(4), pp. 149-161.

Carter, C.A. and B. Zhang, 1994, “Agricultural Efficiency Gains in Centrally Planned Economies”, *Journal of Comparative Economics*, 18, pp. 314-328.

Carter, M.R., 1984, “Resource Allocation and Use under Collective Rights and Labor Management in Peruvian Coastal Agriculture”, *Economic Journal*, 94, pp. 826-846.

Cavallo, D. and Y. Mundlak, 1982, “Agriculture and Economic Growth in an Open Economy: The case of Argentina”, *IFPRI research report* 36, Washington D.C.

Cochrane, W.W., 1955, “Conceptualizing the Supply Relation in Agriculture”, *Journal of Farm economics,* 35(5), pp. 1161-1176.

Coeymans, J.E. and Y. Mundlak, 1993, “Sectoral Growth in Chile: 1962-82”, *IFPRI research report* 95, Washington D.C.

Griliches, Z., 1960, “Estimates of the Aggregate U.S. farm Supply Function”, *Journal of Farm Economics*, 62(2), pp. 282-293.

Griliches, Z., 1963, “The Sources of Measured Productivity Growth: United States Agriculture, 1940-60”, *Journal of Political Economy*, 71, pp. 331-346.

Hatziprokopiou, M., G. Karagiannis, K. Velentzas, 1996, “Production Structure, Technical Change, and Productivity Growth in Albanian Agriculture”, *Journal of Comparative Economics*, 22(3), pp. 295-310.

Hayami, Y., 1969, “Sources of Agricultural Productivity Gap Among Selected Countries” in *American Journal of Agricultural Economics,* 51(3), pp. 564-575.

Hayami, Y. and V.W. Ruttan, 1970, “Agricultural Productivity Differences among Countries” *American Economic Review* 60(3), pp. 895-911.

Hayami, Y. and V.W. Ruttan, 1985, *Agricultural Development: An International Perspective,* Baltimore, John Hopkins University Press.

Herdt, R.W., 1970, “A Disaggregate Approach to Aggregate Supply”, *American Journal of Agricultural Economics*, 52(4), pp. 512-520.

Jackman, R., 1994, “Economic Policy and Employment in the Transition Economies of Central and Eastern Europe: What have we learned?”, *International Labor Review,* 133(3), pp. 327-345.

Jackson, M. and J. Swinnen, 1995, *A Statistical Analysis and Survey of the Current Situation of Agriculture in the Central and Eastern European Countries,* Report for the European Commission, Leuven.

Kalirajan, K.P., M.B. Obwona and S. Zhao, 1996, “A Decomposition of total Factor Productivity Growth: The Case of Chinese Agricultural Growth Before and After Reforms”, *American Journal of Agricultural Economics,* 78, pp. 331-338.

Kawagoe, T., Y. Hayami and V.W. Ruttan, 1985, “The Intercountry Agricultural Production Function and Productivity Differences among Countries”, *Journal of Development Economics*, 19, pp. 113-132.

Lau, L.J. and P.A. Yotopoulos, 1989, "The Meta-production Function Approach to Technological Change in World Agriculture", *Journal of Develoment Economics*, 31, pp. 241-269.
Leibenstein, H., 1966, "Allocative Efficiency versus X-efficiency", *American Economic Review,* 56, pp. 392-415.
Lin, J.Y., 1992, "Rural reforms and Agricultural Growth in China", *American Economic Review,* 82(1), pp. 35-51.
Lin, J.Y., 1993, "Cooperative Farming and Efficiency: Theory and Empirical Evidence from China", in Csaki, C. and Y. Kislev (eds), *Agricultural Co-operatives in Transition,* Westview Press, Boulder, pp. 161-172.
Marek, G. and H. Lehmann, 1992, "Flow and Stock Analysis of Polish Unemployment: January 1990-June 1991", *Labor, Review of Labor Economics and Industrial Relations,* 6(1), pp. 87-119.
Mathijs, E. and J. Swinnen, 1996, "The Economics of Agricultural Decollectivization in Central and Eastern Europe", Working Paper Series of the joint Research Project: *Agricultural Implications of CEEC Accession to the EU,* Working Paper No. 3/1, Department of Agricultural Economics, K.U. Leuven.
McMillan, J., J. Whalley and L. Zhu, 1989, "The Impact of China's Economic Reforms on Agricultural Productivity Growth", *Journal of Political Economy,* 97(4), pp. 781-807.
Mundlak, Y and R. Hellinghausen, 1982, "The Intercountry Agricultural Production Function: Another View", *American Journal of Agricultural Economics,* 64(4), pp. 664-672.
Nguyen, D., 1979, "On Agricultural Productivity Differences among Countries", *American Journal of Agricultural Economics,* 61(3), pp. 565-570.
Peterson, W.L., 1979, "International Farm Prices and the Social Cost of Cheap Food Policies", *American Journal of Agricultural Economics,* 61(1), pp. 12-21.
Peterson, W.L., 1988, "International Supply Response", *Agricultural Economics,* 2(4), pp. 365-374.
Pingali, P.L. and V-T. Xuan, 1992, "Vietnam: Decollectivization and Rice Productivity Growth", *Economic Development and Cultural Change,* 40(4), pp. 697-718.
Rao, D.S.P., K.C. Sharma and W.F. Shepherd, 1991, "On the Aggregation Problem in International Comparisons of Agricultural Production Aggregates", *Journal of Development Economics,* 35, pp. 197-204.
Rao, J.M., 1989, "Agricultural Supply Response: A Survey", *Agricultural Economics,* 3(1), pp. 1-22.
Roberts, B.M., 1995, "Output Decline in Eastern Europe: A Comparison of Explanations for Poland", *Discussion papers in European Economic Studies,* No. 95/1, Leicester, Centre for European Economic Studies.
Schiff, M. and C.E. Montenegro, 1997, "Aggregate Agricultural Supply Response in Developing Countries: A Survey of Selected Issues", *Economic Development and Cultural Change,* 45(2), pp. 393-410.
Schmitt, G., 1993, "Why collectivization of Agriculture in Socialist Countries Has Failed: A Transaction Cost Approach" in Csaki, C. and Y. Kislev (eds), *Agricultural Co-operatives in Transition,* Westview Press, Boulder, pp. 143-159.
Singh, A. and H. Tabatabai, 1992, "Agriculture and Economic Development in the 1990s: A New Analytical and Policy Agenda", *International Labor Review,* 131(4-5), pp. 405-430.
Swinnen, J., 1995, "Agricultural Credit Problems during the Transition to a Market Economy in Central and Eastern Europe" in OECD, *Agro-Food Sector Policy in OECD Countries and the Russian Federation,* Paris: OECD Centre for Co-operation with the Economies in Transition, pp. 50-62.

Swinnen, J., 1996, "Endogenous Price and Trade Policies in Central European Agriculture" in *European Review of Agricultural Economics*, 23(2), pp. 133-160.

Swinnen, J., 1997a, "Agricultural Reform in Central and Eastern Europe" in Eicher, C. and J. Staatz (eds), *Agricultural Development in the Third World*, Third Edition, forthcoming.

Swinnen, J. (ed.), 1997b, *Political Economy of Agrarian Reform in Central and Eastern Europe*, Avebury, Aldershot.

Swinnen, J., A. Buckwell and E. Mathijs (eds), 1997, *Agricultural Privatisation, Land Reform and Farm Restructuring in Central and Eastern Europe,* Avebury Publishers, Aldershot, forthcoming.

Tweeten, L.G. and C.L. Quance, 1969, "Positivistic Measures of Aggregate Supply Elasticities: Some New Approaches", *American Economic Review*, 59(2), pp. 175-183.

Wong, L-F., 1986, *Agricultural Productivity in the Socialist Countries,* Westview Press, London.

APPENDIX: Variable definitions and data sources

* *Gross value of crops* :Values of crop output for each country are calculated from the physical outputs of five major crops: wheat, maize, barley, sugar beet and oilseeds (rapeseed and sunflowerseed). In order to be able to compare agricultural production aggregates of different countries, it is necessary to find a meaningful index for aggregation. Value of production is mostly obtained by taking the weighted sum of physical outputs, the weights being the domestic prices in own currency of a certain year. But, even if the domestic prices would be converted into a common currency, these aggregates would still not reflect comparable real output, as each country's aggregate would be based on prices prevailing in that country. Hayami (1969) tried to solve the problem by introducing "wheat-relatives". Each country's output is revalued using the average of the wheat-relative prices of the US, Japan and India. (The three countries were chosen in 1969 as representatives of different stages of development). As our analysis concerns uniquely CEECs, it makes more sense to use the price structure of CEECs in stead of that from three totally different countries. As Rao et al. (1991) indicate, a repricing method is needed to get an "international price"[13] for each commodity.

For each commodity in the aggregate, we constructed an international price by taking the average of the domestic commodity prices in 1995 in the countries included in the analysis. However, due to unavailability of the data, the commodity prices of Albania could not be included. The prices are expressed in US dollar, using the average exchange rate of 1995. Constant prices are used in order to measure real output changes. As it is recognised that exchange rates were seriously distorted in the CEECs before and during the transition (Bojnec et al.,1997), the year 1995 was chosen because biases in exchange rates are likely to have decreased in time. The data on physical outputs for Albania are taken from the FAO production yearbook (various issues). The price data and the data on physical outputs of the commodities of the other countries are from the dataset of Bojnec and Swinnen.

* *Gross value of livestock output* : The same method was applied as for the crop output. Prices and physical outputs of milk, beefmeat, pigmeat and poultry were used in the calculations. The data on physical outputs for Albania are taken from the FAO production yearbook (various issues). The price data and the data on physical outputs of the commodities of the other countries are from an internal dataset of Bojnec and Swinnen.

[13] In some studies the term "international dollar" in stead of "international price" is used.

* *Average annual output growth* : The percentages, reported in table 1, were calculated based on the obtained values of gross crop, livestock and agricultural output. The table reports the average annual changes during the 4 first years after the actual start of the reforms. (Czech Republic, Hungary, Poland and Slovakia and Slovenia: 1989-1993; Bulgaria and Romania: 1990-1994; Albania: 1991-1995)

* *Capital* is measured by the horsepower of tractors. The number of tractors in use were taken from the FAO production yearbooks (various issues) for Albania, Bulgaria, Hungary, Poland and Romania, from the official statistical offices of the Czech Republic and Slovakia and from a data-set provided by the European Commission for Slovenia. For the conversion to horsepower, we assumed that the average capacity of tractors in a country did not change during the years included in the data-set.

* *Labor* refers to the number of workers in the cropping sector. To estimate this number, we followed the method used by Lin (1992): the economic active population in agriculture was weighted by the value share of crop output in total agricultural output. (Data: OECD AHEG + European Commission, 1995). The economic active population in agriculture is calculated from the total labor force. Total labor force (data from FAO production yearbooks) is diminished with the unemployment share (data from OECD, 1996), to get the total of employed persons. The share of agriculture in total employment as given by the OECD was then used to calculate the economic active population employed in agriculture. (OECD AHEG reports, various issues and OECD,1996).

The reason to use this calculation is that the official data provided by the FAO and the European Commission differ substantially from the data from the official statistical offices from the specific countries, and consequently from the OECD data, as these are largely based on the last ones. The FAO data seem to underestimate the flow of labor out of agriculture. The FAO estimated the data for 1991-1995 using assessments made by ILO. These assessments are actually a projection of trends until 1990, to the following years. (FAO production yearbook 1995, p. IX). It is likely that these projections could not accurately foresee the labor evolutions in the transition countries, and therefore the FAO data seem unreliable. The data from the European Commission, show large discrepancies, notably for the Czech Republic and Slovakia with an unrealistic shift upwards in 1993 and a drastic shift downwards for Slovenia in 1992.

* *Fertiliser* refers to the tons pure nutrient of nitrogenous, phosphate and potash fertilisers. The main source is the FAO fertiliser yearbook 1995, with additions out of official statistical yearbooks of the Czech Republic, Slovakia and Slovenia.

* *Land* refers to harvested area (in hectares) of the commodities included in the analysis. The source of the data is a data-set, provided by the European Commission. For Albania, the data are taken from the FAO Production Yearbook, (various issues).

* *Individual farm variable (IND)*: the difference between the share of total agricultural land used in individual farms in the year of the observation and 1989. Source: Own calculations based on Swinnen (1994), Swinnen, Buckwell, and Mathijs (1997), OECD AHEG reports (various issues), OECD (1995, 1996), East European Agriculture and Food (various issues), and the Hungarian and Romanian Statistical Office.

* *Disruption variable (DISR)*: The percentage of agricultural land that has been involved in restructuring to individual farms in the year of the observation or the year before. It thus measures the difference in the share of agricultural land in individual farms between year t and year t-2. Data are from Swinnen (1994), Swinnen, Buckwell, and Mathijs (1997), OECD AHEG reports (various issues), OECD (1995, 1996), East European Agriculture and Food (various issues), and the Hungarian and Romanian Statistical Office.

* *Privatization variable (PR)* : The difference between the share of agricultural land in private ownership between the year of observation and 1989. Data are from Swinnen (1994), Swinnen, Buckwell, and Mathijs (1997), OECD AHEG reports (various issues), OECD (1995, 1996), East European Agriculture and Food (various issues), and the Hungarian Statistical Office.

* *Uncertainty Variable (UNC)* : Dummy, with the value of 1 in the years of the main policy changes, and the value of 0 in the other years. The years in which the price liberalizations and the land reform laws occurred are taken as the years of main policy changes. Estimations based on Swinnen (1994), Swinnen, Buckwell, and Mathijs (1997) and Christensen (1995).

* *Producer Price (PP)* : Index of the aggregate producer output price. The aggregate producer price is the weighted sum of producer prices in local currency of the commodities included in the data set. The weights are the share of the commodity in total value crop production, the total value crop production being calculated with prices in local currency for 1995. The data are taken from an internal dataset of Bojnec and Swinnen.

* *Input Price Index (IP)*: Due to lack of diversified prices for different inputs, the input price index as given by the OECD (1996) was used. For Slovenia, the index is calculated out of the country report by the European Commission (1995).

* *Weather Index*: Average amount of precipitation from March to June. The choice of the period was determined by the importance of rainfall for the crop production in these months, as was indicated by various issues of East European Agriculture and Food. The index was calculated based on data from various issues of the Statistical yearbooks of Romania, Czech Republic, Bulgaria, Hungary and Poland, and Monatzeitschrift der Deutscher Wetterdienst (various issues).

STATISTICAL SOURCES

Bojnec-Swinnen, 1996, *Agricultural Prices, Trade and Output in Central and Eastern Europe: Data 1986-1995,* unpublished dataset, Department of Agricultural Economics, K.U. Leuven.

Central Statistical Office of Hungary, *Statistical Yearbook of Hungary,* various issues, Budapest.

Czech Statistical Office, *Statistical Yearbook of the Czech Republic*, various issues, Prague.

Comisia nationala pentru statistica Romania, *Informatii statistice operative,* various issues, Bucarest.

Christensen G., 1995, *Policy issues for the agricultural sector in Albania,* FAO project, final report, University of Oxford.

Deutscher Wetterdienst, *Gross Wetterlagen Europas, Monatzeitschrift*, various issues Offenbach.
East European Agriculture and Food, various issues.
European Commission, 1995, *Agricultural situation and prospects in the Central and Eastern European Countries,* Directorate-General for Agriculture working document, Brussels.
European Commission, 1996, *DG IV PECO dataset*, unpublished dataset, Brussels
FAO, *Production Yearbook,* various issues, Rome, Publication Division FAO.
FAO, 1996, Fertilizer Yearbook 1995, Rome, Publication Division FAO.
Glόwny Urzad Statystyczny, *Roznik Statyslyczny,* various issues, Warsau.
National Commision for Statistics of Romania, *Romanian Statistical Yearbook,* various issues, Bucarest.
National Statistical Institute of Bulgaria, *Statistical Yearbook, Republic of Bulgaria,* various issues, Sofia.
OECD, Ad Hoc Expert Group reports, various issues.
OECD, 1995, *Agricultural Policies, Markets and Trade in Transition Economies, Monitoring and Evaluation 1995,* Centre for Co-operation with the Economies in Transition, Paris, OECD publications.
OECD, 1996, *Agricultural Policies, Markets and Trade in Transition Economies, Monitoring and Evaluation 1996,* Centre for Co-operation with the Economies in Transition, Paris, OECD publications.
Pryor, F.L., 1992, *The Red and the Green, The Rise and Fall of Collectivized Agriculture in Marxist Regimes,* Princeton University Press, New Yersey.
Statistical Office of the Republic of Slovenia, *Statistical Yearbook of the Republic of Slovenia,* various issues, Ljubljana.
Statistical Office of the Slovak Republic, *Statistical Yearbook of the Slovak Republic*, various issues, Bratislava.
Swinnen, J. (ed.), 1994, *Policy and Institutional Reform in Central European Agriculture,* Avebury, Aldershot.

Table 1: Annual output growth: first 4 years* after start of the reforms

	Average annual growth rate (%)		
	Crops	**Livestock**	**Total**
Albania	9.7	12.9	11.8
Bulgaria	-2.3	-13.5	-9.6
Czech Rep.	-2.1	-5.7	-4.8
Hungary	-10.7	-8.3	-9.7
Poland	-2.3	-4.0	-3.8
Romania	4.4	-1.6	-0.1
Slovakia	-6.6	-7.6	-7.5
Slovenia	-2.6	-0.2	-0.6

* 1989-1993 for Czech Republic, Hungary, Poland, Slovakia and Slovenia; 1990-1994 for Bulgaria and Romania; and 1991-1995 for Albania.

Source: Own calculations based on Bojnec-Swinnen, FAO, and National Statistics. For detailed information: see appendix.

Table 2: Land Privatization methods

	Collective farm land	State farm land
Albania	Distribution	Distribution
Bulgaria	Restitution	Mixed
Czech Republic	Restitution	Sale (leasing*)
Hungary	Restitution + distribution + sale for compens. bons	Sale for compens.bons + sale (leasing*)
Poland	-	Sale (leasing*)
Romania	Restitution + distribution	Undecided + restitution
Slovakia	Restitution	Sale (leasing*)
Slovenia	-	Restitution

* Land is leased to individuals or entities in attendance of sale.

Source: Swinnen (1997a)

Table 3: Share of agricultural land in private ownership (% of total agric. land)

	1989	1993	1995
Albania	3	90	96
Bulgaria	14	42	59
Czech Republic	-	65	81
Hungary	13	50	90
Poland	76	76	77
Romania	14	70	80
Slovakia	-	54	90
Slovenia	83	85	86

Source: see appendix

Table 4: Changes in farm structure (based on % of agricultural land use)

	State farms (%)		*Cooperatives (%)*		*Companies and partnerships(%)*		*Individual farms (%)*	
	1987	*1994*	*1987*	*1994*	*1987*	*1994*	*1987*	*1994*
Albania[a]	21.1	5.0	78.4	-	-	-	0.5	95.0
Bulgaria[b]	90.0[c]	7.0	-	48.2	-	0.9	10.0	43.9
Czech Republic	38.0	2.8	61.0	47.7	-	20.8	1.0	20.4
Hungary[d]	14.9	-	71.4	29.3	-	33.2	13.7	22.3
Poland	18.4	11.4	3.6	3.6	-	-	78.0	85.0
Romania	29.8	13.3	54.7	13.7	-	11.9	15.6	61.1
Slovakia	26.0	20.3	68.0	69.9	-	4.6	6.0	5.3
Slovenia	11.0	8.0	-	-	-	-	89.0	92.0

a Before reform: 1983 and based on cultivated land
b After reform: based on arable land
c Includes Agro-Industrial Complexes of which an important part were previous collective farms
d Companies include transformed state farms

Source: Pryor (1992), East European Agriculture and Food, and Swinnen (1997a)

Table 5: Importance and labor intensity of agriculture in 1994

	Share of agriculture in total employment (%)	Share of agriculture in GNP (%)	Man-land ratio[a] (pers./ha)
Czech Republic	5.1	3.1	0.06
Slovakia	7.2	6.5	0.07
Hungary	8.8	6.4	0.06
Slovenia	10.7	6.2	0.12
Poland	25.9	4.3	0.23
Bulgaria	21.7	11.0	0.14
Romania	36.3	19.7	0.23
Albania	53.0	55.0	0.57

[a] Number of persons employed in agriculture over total agricultural land (in hectares)

Source: Bojnec-Swinnen (1996), OECD (1996), FAO , National Statistics

Table 6: Results of production function estimations

Dependent variable: ln(OUTPUT)				
No of countries	8		8	
No of observations	47		47	
	Coefficient (1)	t-value	Coefficient (2)	t-value
Intercept	-0.0052	-0.15	0.0041	0.15
ln(CAPITAL)	0.2993	2.03	0.2970	2.04
ln(LABOR)	0.2672	1.43	0.2582	1.40
ln(FERT)	0.1456	2.96	0.1503	3.16
ln(LAND)	0.5377	1.31	0.5315	1.31
Individual farm	0.0058	1.49	0.0055	1.45
Disruption	-0.0068	-2.77	-0.0066	-2.76
Privatization	-0.0039	-1.15	-0.0037	-1.11
CSH dummy	0.0077	1.98	0.0074	1.95
Uncertainty	0.0185	0.44	-	
R^2	0.7647		0.7634	
Adj R^2	0.7074		0.7136	

Table 7: Results of the supply response function estimations

Dependent variable: ln(OUTPUT)

Number of countries	7		7		7		7	
Number of observations	46		46		46		46	
	Coefficient (1)	t-value	Coefficient (2)	t-value	Coefficient (3)	t-value	Coefficient (4)	t-value
Intercept	0.0046	0.16	0.0041	0.15	0.0052	0.18	0.0138	0.50
ln(PP/IP)	0.2309	6.15	0.2315	6.18	0.2270	5.84	0.2348	6.20
ln(WEATHER)	0.3016	5.81	0.3017	5.81	0.3198	5.59	0.2989	5.69
IND	0.0078	2.43	0.0079	2.47	0.0057	2.27	0.0044	2.11
DISR	-0.0109	-2.87	-0.0109	-2.89	-0.0106	-2.76	-0.0101	-2.67
PR	-0.0031	-1.68	-0.0031	-1.72	-0.0016	-1.40	-0.0007	-1.15
CSH	0.0022	1.38	-					
CSH+PS dummy*	-		0.0023	1.42	-		-	
UNC	-0.0417	-1.27	-0.0410	-1.2539	-0.0528	-1.66	-0.0547	-1.73
Time trend TSH	-		-		0.0129	0.93	-	
R^2	0.7339		0.7347		0.7268		0.7206	
Adj R^2	0.6849		0.6858		0.6765		0.6776	

* CSH: the Czech Republic, Slovakia and Hungary; PS: Poland and Slovenia

Table 8: Accounting for output changes: production function

Explanatory variable	Estimated Coefficient	Change in Variable	Contribution to output change		
			Absolute	% of total change	% of explained change
Production factors			**-6.15**	**-82.44**	**-99.44**
Machinery	0.2970	-12.14	-3.61	-20.57	-24.82
Labor	0.2582	-9.84	-2.54	-14.49	-17.48
Fert	0.1503	-49.38	-7.42	-42.34	-51.07
Land	0.5315	-1.66	-0.88	-5.03	-6.07
Restructuring			**2.34**	**13.34**	**16.09**
Individual farm	0.0055	1574.87	8.62	49.17	59.31
Disruption	-0.0066	945.64	-6.28	-35.83	-43.21
Privatization			**-2.42**	**-13.81**	**-16.65**
Albania, Romania, Bulgaria, Poland, Slovenia	-0.0037	2670.83	-9.84	-56.12	-67.69
Czech Rep., Hungary, Slovakia	0.0037	2566.67	9.45	53.90	65.01
Residual			-3.00	-17.10	
Total output change			**-17.53**	**-100**	**-100**

We use the estimations of column (2) in table 4 for the output change accounting as the coefficient for uncertainty in column (1) was not significant different from 0. The coefficient of PR and CSH were added to obtain the total effect for the Czech Republic, Slovakia and Hungary. For the conventional inputs, the coefficients of the Cobb-Douglas function give the elasticities of production. By multiplying the coefficients with the % change of these variables, one obtains the contribution of the variable to output change. The IND, DISR, and PR are in semi-log form in the production function. Therefore we first calculate the differences between the magnitude of these variables in 1990 to 1994 and the magnitude in 1989. Then we multiply the coefficient with the average of these differences to calculate the contribution to output change. As output change is expressed in percentage, we multiply the coefficients with 100. To obtain the contribution of privatization to the average output change, we took the weighted average of the contributions in the different countries. Changes in output and input are calculated from table 1, changes in the other variables from table 2.

Table 9: Accounting for output changes: supply function

Explanatory variable	Estimated coefficient	Change in variable	Contribution to output change		
			Absolute	% of total change	% of explained change
PP/IP	0.2309	-29.48	**-6.81**	**-45.37**	**-51.23**
WEATHER	0.3016	-4.92	**-1.49**	**-9.90**	**-11.18**
Restructuring			**1.62**	**10.78**	**12.17**
Individual farm	0.0078	1168.21	9.13	60.83	68.69
Disruption	-0.0109	691.79	-7.51	-50.06	-56.52
Privatization			**-4.90**	**-32.67**	**-36.88**
Romania,Bulgaria, Poland, Slovenia	-0.0031	2109.52	-6.48	-43.22	-48.80
Czech Republic, Slovakia,Hungary	-0.0009	3505.56	-3.05	-20.35	-22.98
Uncertainty	-0.0417	41.03	**-1.71**	**-11.40**	**-12.87**
Residual			-1.72	-11.44	
Total output change			**-15.00**	**-100**	**-100**

We use the estimations of table 5 for the output change accounting. . The coefficient of PR and CSH were added to obtain the total effect for the Czech Republic, Slovakia and Hungary. PP/IP and WEATHER enter the supply function in log lineair form. By multiplying the coefficients with the % change of these variables, one becomes the contribution of the variable to output change. The IND, DISR, PR and UNC are in semi-log form in the production function. Therefor we first calculate the differences between the magnitude of these variables in 1990 to 1994 and the magnitude in 1989. Than we multiply the coefficient with the average of these differences to calculate the contribution to output change. As output change is expressed in percentage, we multiply the coefficients with 100. To obtain the contribution of privatization to the average output change, we took the weighted average of the contributions in the different countries. Changes in output and explanatory variables are calculated from table 2.

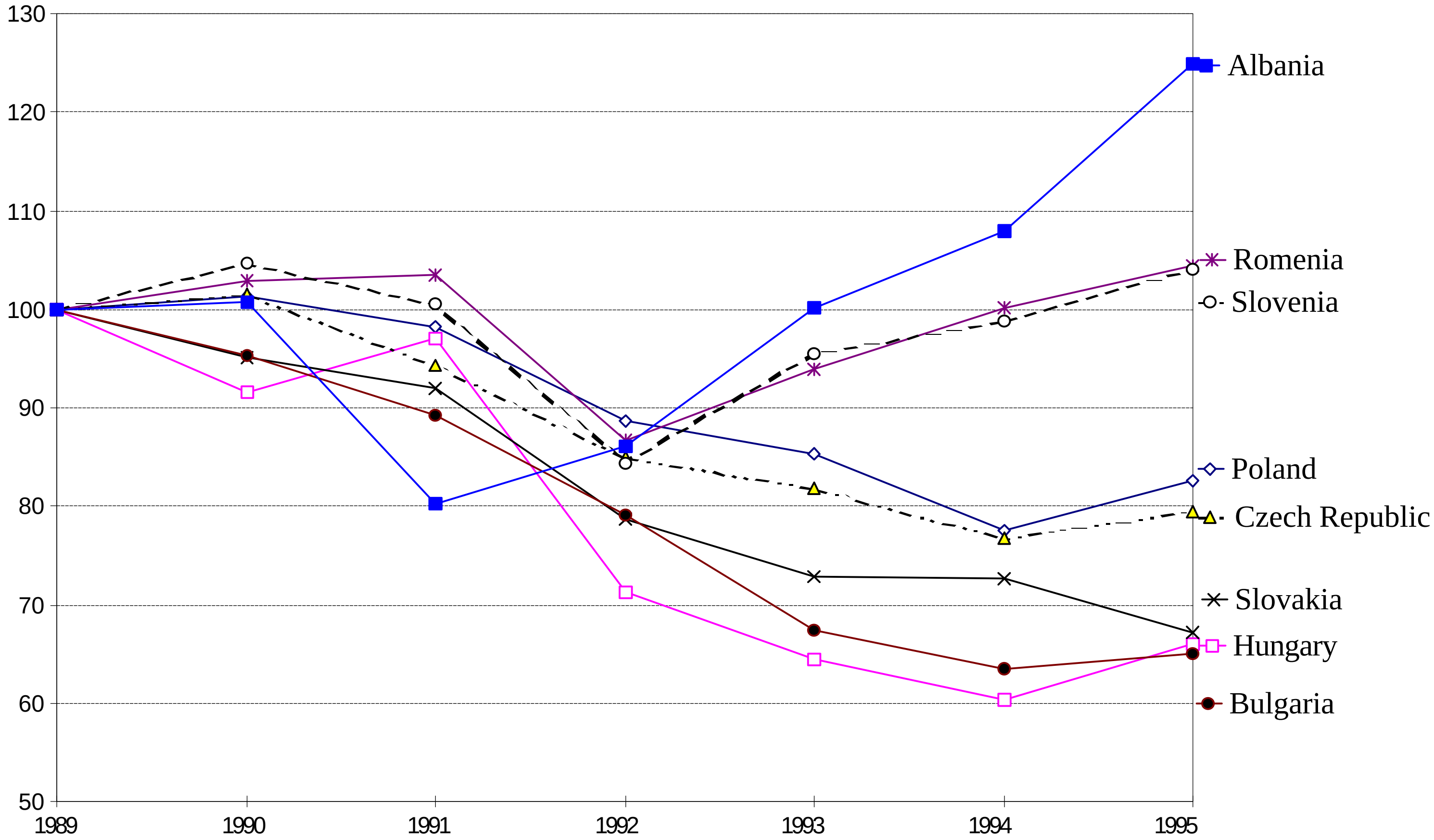
Table 10: Output change accounting with supply and production function (1989-1994)

Explanatory variable	Estimated coefficient	Change in variable	Contribution to output change absolute	Contribution to output change %
Production factors			**-13.00**	**-84.35**
Capital	0.2970	-11.42	-3.39	-22.01
Labor	0.2582	-9.90	-2.56	-16.59
Fert	0.1503	-51.16	-7.69	-49.89
Land	0.5315	1.20	0.64	4.15
Restructuring			**1.23**	**7.95**
Individual farm	0.0055	921.82	5.04	32.73
Disruption	-0.0066	575.15	-3.82	-24.78
Privatization			**0.60**	**3.89**
Bulgaria, Romania, Poland, Slovenia	-0.0037	1838.89	-6.77	-43.95
Czech Rep., Slovakia, Hungary	0.0037	2566.67	9.45	61.30
Residual			-4.24	-27.49
Total output change			**-15.41**	**-100**

Explanatory variable	Estimated coefficient	Change in variable	Contribution to output change absolute	Contribution to output change %
PP/IP	0.2309	-26.90	**-6.21**	**-40.31**
WEATHER	0.3016	-9.54	**-2.88**	**-18.67**
Uncertainty	-0.0417	48.48	**-2.02**	**-13.12**
Restructuring			**0.96**	**6.22**
Individual farm	0.0078	921.82	7.20	46.73
Disruption	-0.0109	575.15	-6.24	-40.51
Privatization			**-4.10**	**-26.60**
Bulgaria, Romania, Poland, Slovenia	-0.0031	1838.89	-5.65	-36.68
Czech Rep., Slovakia, Hungary	-0.0009	2566.67	-2.24	-14.51
Residual			-1.16	-7.52
Total output change			**-15.41**	**-100**

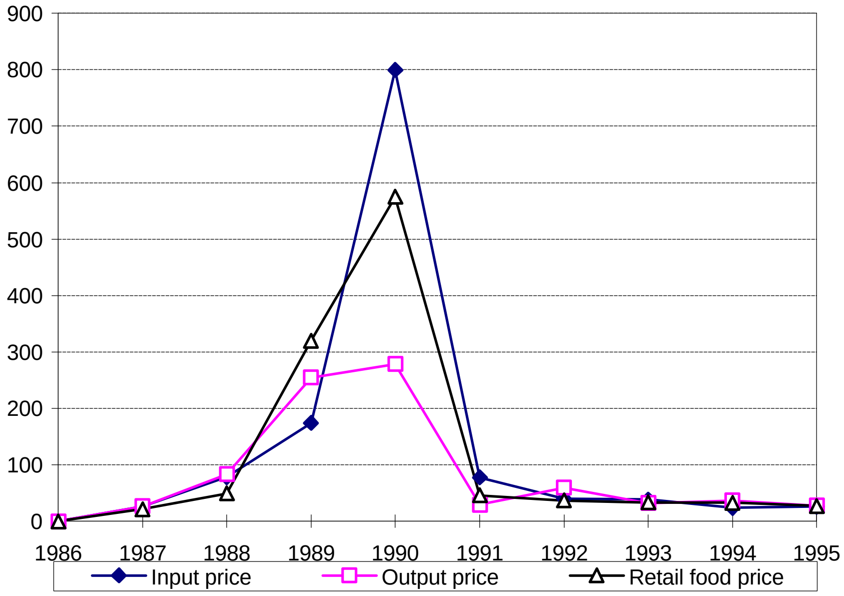
Explanation: see table 8 and 9

Figure 1: Change in Gross Agricultural Output (GAO) between 1989 and 1995



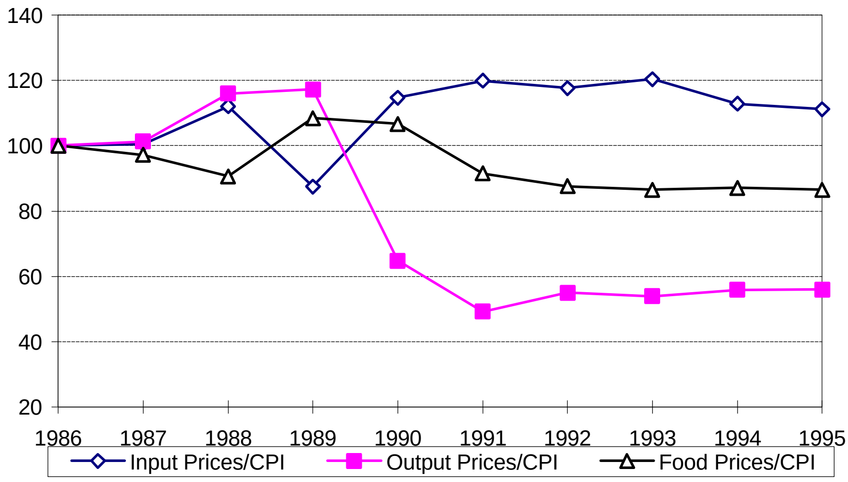
Source: Bojnec-Swinnen (1996), FAO and National Statistics (see appendix for detailed information)

Figure 2: Changes of input, output and retail prices in the Polish agro-food sector (% annual change)



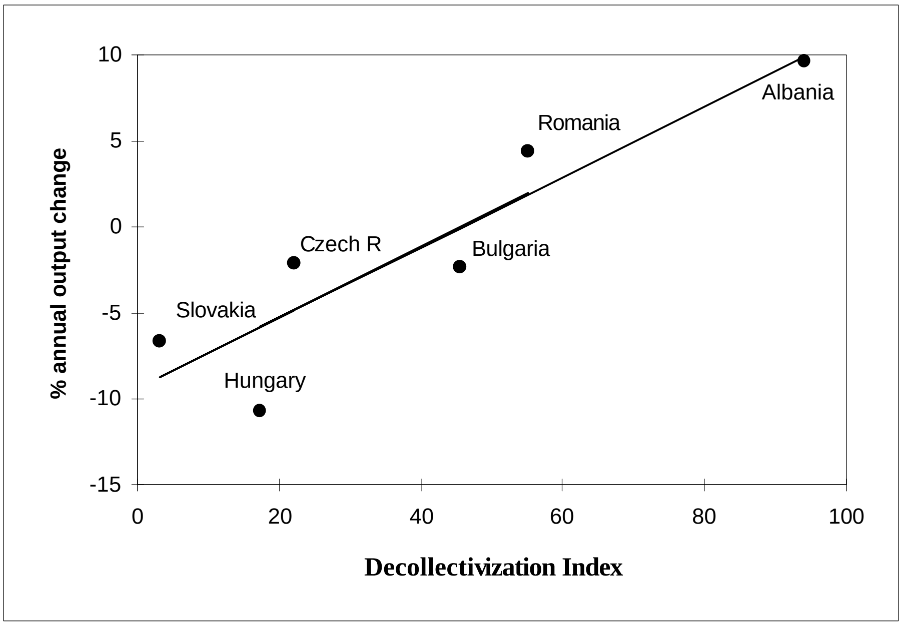
Source: OECD (1996)

Figure 3: Relative change of real input, output en retail prices in the Polish agro-food sector



Source: OECD (1996)

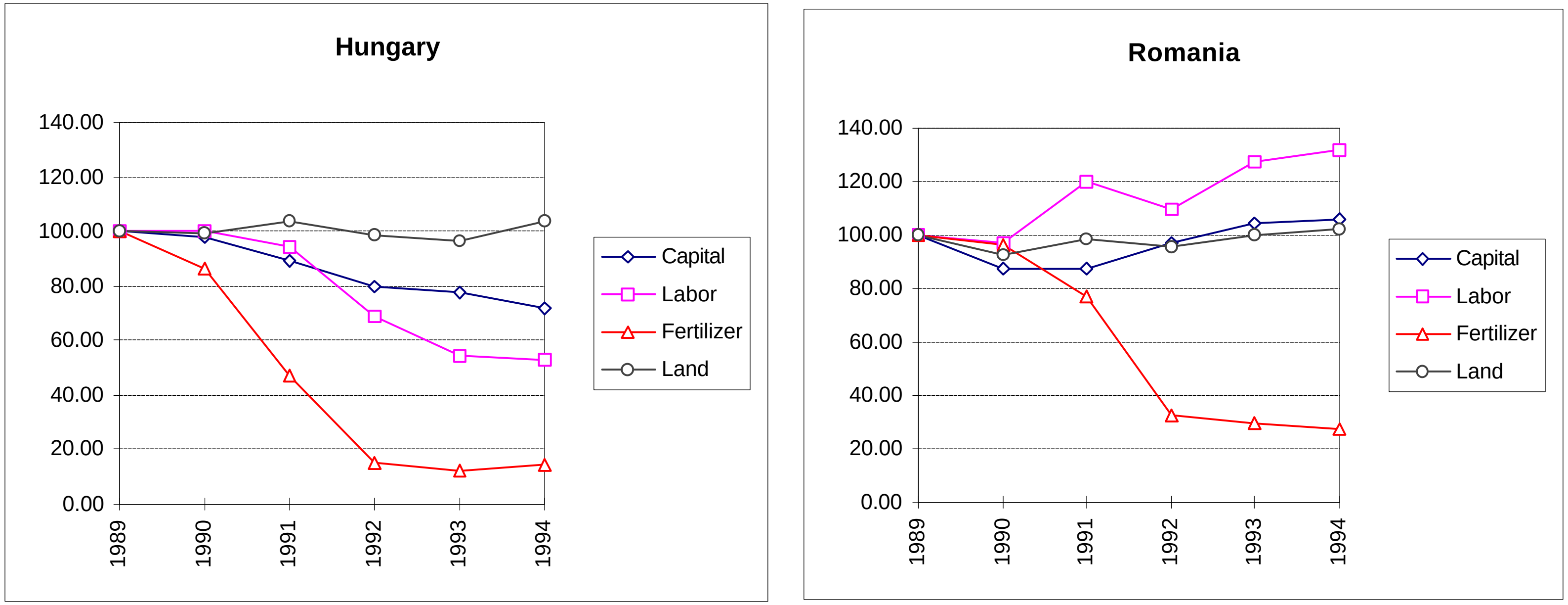
Figure 4: Decollectivization Index [a] and Average Annual Crop Output Change (during first 4 years of the reforms[b])



a The Decollectivization Index is calculated by dividing the difference between the share of individual farms in total agricultural land in 1995 and in 1989 by 100 minus the share of individual farms in total agricultural land in 1989 (Mathijs and Swinnen, 1996).

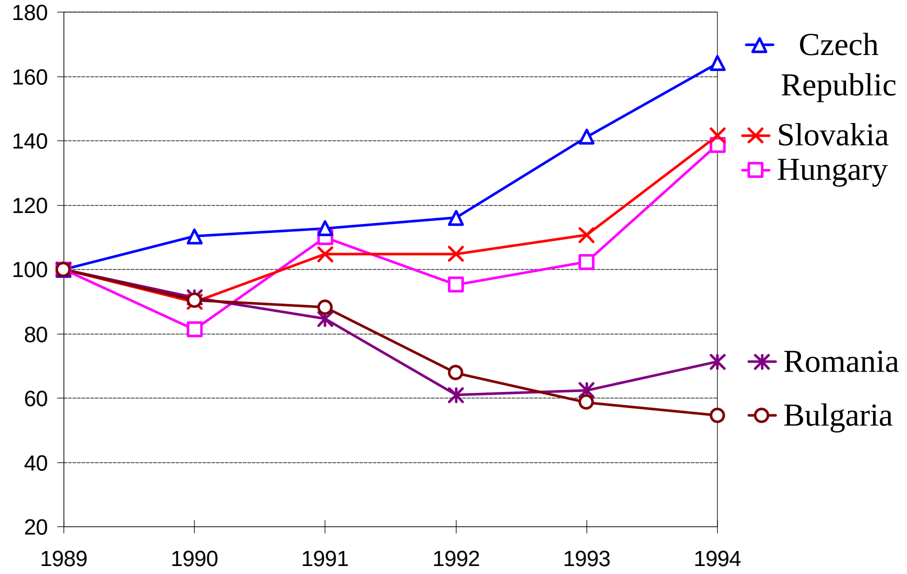
b 1989-1993 for The Czech Republic, Hungary and Slovakia; 1990-1994 for Bulgaria and Romania; and 1991-1995 for Albania.

Figure 5: Changes in Input Use in Agriculture in Hungary and Romania (1989 - 1994)



Source: see appendix

Figure 6: Change in Labor Productivity (*)



(*) Value of crop production per person employed in crop production

Source: see appendix