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Farm productivity and efficiency in the CEE applicant countries: a synthesis of results

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Abstract

This article draws together results from farm efficiency studies in six Central and East European countries that are part of the EU enlargement process. The main questions addressed concern whether there is a clear superiority of one organisational type, namely, family farms, over corporate structures (production co-operatives and various types of farming companies) and the nature of the relationship between size and farm efficiency. Results from empirical research show that there is no clear cut evidence of corporate farms being inherently less efficient for all farming activities than family farms. Where significant differences have been found in favour of family farms against the average corporate farm, the best corporate farms still tend to perform as well as the best family farms. As far as size is concerned, in countries in transition where small family farms are well established and managed continuously by the present farm household, they appear to be less inefficient compared to larger cohorts as against countries where small family farms are a relatively new phenomenon.

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1. Introduction

Since the beginning of transition, academics and policy makers have been interested in the relative efficiency of farming in Central and East European Countries (CEECs). This interest has been stimulated by the desire to understand how the CEECs may fair in an enlarged European Union (EU), given that overall agriculture accounts for a larger share of GDP

and employment in the candidate states. This avenue of research was given further prominence after early studies noted large variations between farms in terms of their relative efficiency. Understanding why farms differ in their relative efficiency has been seen as crucial to several debates concerning likely future structural change (Mathijs and Swinnen, 1998), supply response (Hughes, 2000a), the size of the agricultural labour force (Rizov et al., 2001) and international competitiveness (Gorton and Davidova, 2001). However, previous studies have used a variety of competing methods to investigate farm efficiency with results presented on a country by country basis. This paper attempts to draw together these individual

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country studies to present a synthesis of findings from the region and draw out relevant cross-national patterns. It concentrates on six of the ten CEECs that are part of the EU enlargement process. Only studies covering the post-communist period are included.

The paper is structured as follows. The next section reviews the main frameworks employed for considering farm performance and factors affecting farm efficiency. Section 3 outlines the empirical studies conducted for the CEECs and the methodologies employed. Attention is given to the differences between methodologies and their importance for the interpretation of results. The findings of farm efficiency studies for the CEECs are presented in Section 4 with the discussion grouped around the debate on farm size, organisational type and other factors. Conclusions are drawn in Section 5.

2. Factors affecting farm efficiency

Studies of farm performance and agricultural transformation in the CEECs have largely been embedded within one of two widely-used theoretical frameworks. First, broadly *neo-classical* studies have attempted to understand variations in farm performance, particularly technical efficiency, through recourse to differences in the internal structure of farms (especially size and legal type) and agency factors such as the level of human capital (Mathijs and Vranken, 2000; Hughes, 2000b). In these studies the unit of analysis is the individual farm and a common assumption has been that understanding variations in technical efficiency provides a basis for predicting structural change (Hughes, 2000b). The second set of studies, drawing on the writings of institutional economists, argue that human behaviour is shaped by institutions (formal and informal rules, regulations and laws) (Williamson, 1988). In this framework the unit of analysis should not merely be the internal structure of farms but rather capture a farm's institutional embeddedness and inter-organisational relationships (transaction costs) (Pollak, 1985). Variation in technical efficiency is only one of a number of factors that may explain structural change in agriculture and the efficiency of a farm will be determined by both intra- and inter-organisational arrangements (Brem and Kim, 2000). Authors within this school have been

particularly interested in governance problems, path dependency and variations in transaction costs between family and corporate farms as factors that may explain organisational change in the CEECs (Schmitt, 1993; Brem, 2000). The remainder of this section reviews the literature on factors identified by both schools that may explain variations in farm efficiency.

2.1. Economies of size and the 'optimal farm size' debate

The literature on transitional economies has witnessed a wide debate about the relationship between farm size and efficiency as land reform and farm restructuring have brought about comprehensive, politically induced changes in the distribution of farm sizes. When land reform strategies were formulated at the outset of transition, some argued that it was desirable to preserve large farm structures and pursue attempts to administratively impede farm fragmentation on the basis that smaller farms are less efficient. These authors tended to see restitution strategies, where they would lead to farm structures returning to the pre-war pattern of small-scale peasant units, as highly undesirable (Kanchev, 2000). In contrast, others argued that the large farms in Eastern Europe suffered from diseconomies of size so that land reform strategies must include proposals to reduce the mean size of farms (Koester and Striewe, 1999).

Debates concerning the 'optimal farm structure' and 'optimal farm size' have a long history in agricultural economics. Writings on Western economies have sought to understand whether larger farms benefit from being more technically efficient (which may be decomposed into pure technical efficiency and scale effects), and/or more allocatively efficient (Hall and LeVeen, 1978). As mean farm sizes in Western economies have increased, many have hypothesised that significant size effects exist (Seckler and Young, 1978). This assumes that firms in a competitive industry will be driven to produce at the lowest point of the long-run average cost (LAC) curve and that the frequency distribution of farm sizes will reveal the lowest LAC point. From this one can infer that rising mean sizes indicates the presence of economies of size (Seckler and Young, 1978). It was initially assumed that the LAC curve is U-shaped, but empirical research for Western agriculture has tended

to indicate that an L-shaped curve is more prevalent. Dawson and Hubbard (1987), for example, found sharply decreasing LAC curves when small farms grow to a 'family' size in the UK but much less evidence for increasing costs for the group of largest farms. These findings imply that increasing average farm sizes do not necessarily imply the presence of economies of scale, merely the absence of significant diseconomies (Seckler and Young, 1978; Dawson and Hubbard, 1987).

Research on developing countries has centred round the 'inverse hypothesis' that smaller farms are more productive because land is used more intensively (Bharadwaj, 1974; Johnson and Ruttan, 1994; Cornia, 1985). These studies, have largely concentrated on partial productivity measures, typically yields per hectare, with size measured in terms of total hectares (ha) managed (Barrett, 1998) and often fail to account for the differential use of other inputs. The most common explanation of the inverse hypothesis has been labour market dualism. According to this theory, households are believed to face a lower opportunity cost of labour than large, commercial farms. As a result, small farms apply their own labour in such quantities that the expected marginal value product of household labour applied to own cultivation is less than a market-wage-based measure of the opportunity cost of labour (Carter and Wiebe, 1990). Assuming agricultural production technology does not exhibit increasing returns to scale, peasant farms with a presumed proclivity to labour (Barrett, 1998), yield an inverse relationship between farm size and productivity. Binswanger and Elgin (1998) use this theory to explain why small-scale private plots produced a disproportionate share of agricultural output in the CEECs during the communist period. While these traditional Western European and development literatures approach the size-efficiency debate from different perspectives, they are both united in a belief that an optimal farm size can be determined by empirical study and that this should be promoted (Munroe, 2001).

Traditional approaches to the size-efficiency debate have been increasingly criticised on both empirical and conceptual grounds (Kislev and Peterson, 1996). Conceptually, Kislev and Peterson (1996) argue that scale economies are temporary disequilibrium phenomena that persist only under specific circumstances. Several

authors have argued that the observed relationships between farm size and efficiency may be due to unobserved variables and that traditional explanations of farm growth as a mechanism for exploiting economies of size are insufficient to explain the growth in mean farm sizes. This is developed by Seckler and Young (1978) who argue that differences in management input are more important: farms with good managers yield profits to invest in land to increase their income and may purchase loss-making farms that have inferior management. So, what is revealed in practice, that mean farm size increases and that larger farms are more profitable and efficient, is rather related to the influence of management than to the relationship between size and efficiency per se. Such a trend could occur even if the LAC curve was horizontal (Seckler and Young, 1978). A discussion of other 'missing variables' is presented in Section 2.3 below.

The empirical measures used to classify farm size have also been criticised. As Lund (1983) notes, there has been no generally accepted measure of firm size in the economics literature to guide the choice in agricultural studies. Various measures of outputs, inputs (both flow and stock based such as the number of employees or value of fixed capital), and of incomes have been employed. The most commonly employed agricultural measure, geographical land area managed, may be inappropriate for capturing differences in farming systems, for example the size of intensive livestock production. Another commonly used set of measures of farm size are those based on the stocking of different types of animals and sown areas for crops, often weighted on the basis of the typical gross margins earned or the typical amount of labour input (Lund and Price, 1998). These weighting approaches have been used to estimate standard gross margins (SGM) which are used to estimate European Size Units (ESUs), based on periodically revised evaluations of the SGMS earned from livestock and other land uses (Lund and Price, 1998). However ESUs have rarely been used as a measure of farm size in efficiency studies.

Having used one measure of size, it has been common for empirical studies to divide samples into two groups, of 'large' and 'small' farms (Verma and Bromley, 1987). This approach suffers from the arbitrary nature of the division of what is essentially a continuous variable and a lack of evidence on whether the results are robust with respect to other groupings

(Doran, 1985). In dealing with this, Doran (1985) suggests applying a logistic function that enables the data to determine whether a simple classification into small and large is appropriate and, if so, what the cut-off value should be.

In classifying farm size, two other empirical issues should be noted surrounding farm fragmentation and differences between land ownership and use. The issue of farm fragmentation has been highlighted in the development economics literature as, for example, Sau (1973) for India notes that a farm of 20 ha will typically be comprised of five separate plots. A consideration of farm fragmentation in efficiency studies appears important as work on China by Nguyen et al. (1996) found that gains were associated with economies in plot size rather than farm size. Given the nature of decollectivisation processes in the CEECs and the structure of peasant farms that were never collectivised, farm fragmentation is a concern in the region. Mech (1999) reports a high degree of land fragmentation in Poland with “small long strips of ribbon-like fields” prevailing. Second, the distribution of farm sizes may be very different according to whether measured by ownership or management (Binswanger et al., 1993). This is a particular issue in the CEECs where restitution has dramatically increased the number of owners, many of whom however choose to rent out their land to corporate actors. As Swain (1998) notes, decollectivisation in the region has created a structure of rental arrangements in which many own and few rent, the inverse of the historical norm and Western patterns.

Given these empirical and conceptual issues, Verma and Bromley (1987) argue that size is a relative concept and studies that do not recognise this are of limited usefulness. The search for a single ‘optimal size’ is futile given the heterogeneity of farming systems and specialisation of factors of production. Instead Verma and Bromley (1987) conclude that the “fetish for farm size-productivity relations” has detracted analytical attention from understanding the importance of the larger institutional and infrastructural environment.

2.2. Organisational type

At the beginning of the transition process, there were several assumptions about the farm structures

that would emerge as a result of land reform and farm restructuring in the CEECs. These assumptions were widely shared by academics and the main international donors (World Bank, 1998). The most common view was the strong belief that once the centrally planned system had been dismantled, farm structures would go back to their ‘normal’ trajectory, namely smaller individual/family type farms (Csaki and Lerman, 1996). On economic grounds, this assumption was based on the view that family farms are more efficient than co-operatives and other types of corporate farms (Schmitt, 1991). The formulated hypothesis (Schmitt, 1993; Hagedorn, 1994) is that “if the freedom of self-organisation is guaranteed, mainly family farms develop and survive, except for explicable exceptions, because they have low transaction costs” (Hagedorn, 1994, p. 5). One of descriptive arguments employed in support of this hypothesis is that in Western Europe family farms predominate. Hagedorn (1994), however, acknowledges that although family farms are expected to be the main outcome from the institutional reorganisation of socialised agriculture, they may differ from the present structure in Western Europe, mainly in a sense of a higher proportion of larger farms employing non-family labour.

Studies employing a New Institutional Economics framework have attempted to explain the circumstances under which it could be expected that one organisational form is preferred (Allen and Lueck, 1998; Roumasset, 1995). Allen and Lueck (1998) present a model of farm organisation with at one end of a spectrum “pure family farms”, with labour paid by residual claims, and at the other “factory style corporate agriculture”, where farms have many owners and specialised wage labour. In between are various partnerships. As the family farmer is the full residual claimant, there are no moral hazard costs associated with a worker’s gains from shirking. However, due to the lack of labour task specialisation in the family farm, the marginal product of labour in any given task is lower than in the case of specialised labour in the corporate farms. In addition, family farmers have the highest capital costs, as they lack the pool of resources that is available to corporate farms from their group of owners. As a result, family farms are smaller than partnerships and corporate farms, and possess less equipment. At the opposite end of the spectrum, the ‘factory style’ corporate farms have

high costs to monitor labour as hired workers have incentives to shirk. However, as corporations face the lowest capital costs they are more capital intensive. The quantity of hired labour depends on the balance between the gains from specialisation and the costs of monitoring. From these propositions, Allen and Lueck (1998) argue that corporate farming will be more efficient and predominate when the production task makes it less costly for the residual claimant to relate individual effort to commonly produced results (such as capital intensive, less seasonal sectors like poultry or horticultural production). Using data from Canada and the USA, they argue that arable farming will continue to be dominated by family farming as waged labour is difficult to monitor and the benefits of specialisation are limited. In contrast, livestock production, which is typically more spatially concentrated and where farmers can better control the effects of nature and accurately monitor individual labour, will gravitate toward large scale corporate forms as found in the rest of the economy (Allen and Lueck, 1998). In this model, the nature of the production system determines which organisational type will be more efficient. Brem and Kim (2000) have applied this framework to study the reorganisation of Czech agriculture. However, as they note, farm governance structures in transitional economies are typically more complex than the stylised models of agricultural firms presented by Allen and Lueck (1998). Labourers in corporate farms (producer co-operatives or other type of companies) are often not only wage earners, but also residual claimants as they contribute land and non-land assets to the company.

2.3. Other factors affecting farm productivity and efficiency

A host of other issues has been investigated in studying variations in farm efficiency, and these can be divided into agency and structural factors. The most common agency factor investigated has been human capital. Stefanou and Saxena (1988) test for the effects of education and training of farm operators on efficiency. They found that both education and experience have a significant positive effect on the level of efficiency and that they are substitutes. Welch (1970) treats education as a factor of production and attributes the 'productive value of education' to two different

phenomena. The first is the 'worker's effect' that permits the worker to achieve more with the available resources, and the second is 'allocative effect' that enhances a worker's ability to acquire and decode information about other inputs (Welch, 1970). Sumner and Leiby (1987) link the importance of human capital to the size debate by arguing that the selection of people to engage in farming and their decision to stay in the sector will affect the size distribution. Particular emphasis is placed on experience in farming (Sumner and Leiby, 1987; Evans, 1987), as farmers with more experience have lower average marginal production costs and may choose to operate larger farms. This variability in management input, human and other resources implies that there may be more variation in productivity within farm size groups than between size groups due to factors other than economies of size (Buckwell and Davidova, 1993).

Regarding structural factors, these can be divided into on-farm and off-farm issues. The most prominent on-farm issue investigated has been agri-environmental conditions, including soil quality, altitude, climate, rainfall and access to water. For example, Davidova et al. (2002) found a significant effect of farm location on efficiency in the Navarra region of Spain with the best performing farms located in the middle of the region and the worst in the northern counties due largely to their mountainous landscape. Environmental factors have been seen as the 'missing variables' from assessments of economies of size (Bhalla and Roy, 1988). For example, Benjamin (1995) claims that unobserved agri-environmental factors are responsible for the observed inverse productivity relationship seen in studies of developing agriculture. Using data on rice production in Java he argues that to the extent that high-quality land is subdivided more often than low quality land, yields per hectare are greater for smaller farms. Bhalla and Roy (1988) also found that differences in soil quality across households within the same district partially explain the inverse productivity relationship. In other words, land quality is one determinant of farm size and efficiency studies should account for this. Finally regarding on-farm structures, security of land ownership rights can effect farm performance (Cristoiu, 2001) as farms with more secure ownership rights are more prone to make long-term investments and so may display higher efficiency.

Off-farm structural factors include wider institutional factors such as up- and downstream relationships and the nature of transaction costs between agents along agri-food supply chains. For example, the performance gains from better functioning upstream markets may include better terms of trade that lower the average costs of production. Similarly, farms may benefit from the 'backward transmission' of scale economies from the downstream sector via improved contractual arrangements with processors or marketing enterprises (Hughes, 2000a). The nature of supply chain relationships has been seen as critical by some authors in explaining the performance of post-communist agriculture in the region (Hughes, 2000a; Gow and Swinnen, 2001). Hughes (2000a) for example argues that some CEECs have institutional environments that are more conducive to small-scale farming than others because supply and marketing opportunities were better developed in the pre-reform period with lower transaction costs. Acquired learning is also important. Established farms may benefit from accumulated social capital which can provide advantages in negotiations with input suppliers, creditors and processing firms (Meurs, 2001).

In summary, the farm size-efficiency debate on its own is too restrictive a framework for studying variations in farm performance in the CEECs. No absolute generalisations can be made regarding an optimal farm size (Binswanger and Elgin, 1998), as the optimal farm size for a particular production system in a particular country will depend on a set of structural and agency factors.

3. Methodologies employed and studies conducted

Broadly three sets of approaches to the measurement of production efficiency can be delineated: parametric techniques (deterministic and stochastic), non-parametric techniques based on Data Envelopment Analysis (DEA), and productivity indices based on growth accounting and index theory principles (Coelli et al., 1998). Each of these broad approaches has been applied in studies on the CEECs (Table 1). Before reviewing the empirical results of these studies it is necessary to understand the differences between

these methods and how such variations can affect the results presented.

The deterministic frontier approach attributes all deviations from the frontier to inefficiencies. Therefore, it does not take into account the effects of errors of measurement and other random noises. For this reason, it has not usually been applied to efficiency estimations in transition economies, except in studies with a stronger emphasis on methodological comparison (Piesse, 1999). In contrast, the stochastic frontier (Aigner et al., 1977; Meeusen and van den Broeck, 1977) accounts for the effect of random factors such as errors of measurement, unspecified variables, or hazard factors. Morrison (2000) and Curtiss (2000) have used the stochastic frontier approach in farm efficiency studies on transition countries. It has been acknowledged that data from transition economies are generally noisy in comparison to those from developed economies (Morrison, 2000). From this point of view, the stochastic frontier approach is more appropriate than the deterministic one.

The stochastic frontier methodology is, however, more suitable for a single-output case. In multiple output situations, data must be aggregated and this requires price data, which are not always readily available for transition countries. There is also another point that raises doubts about the appropriateness of the production frontier approach to farm efficiency studies for the CEECs. If farms operate using different technologies, the production function becomes farm-specific. In this case the assumption that the slope coefficients are equal across farms is no longer valid and the measurement of efficiency is not reliable (Lansik, 2000). The assumption that all farms in transition economies apply the same technology is quite strong. At the very least, there are differences between individual and corporate farms, particularly co-operatives. For example, in the Czech Republic limited liability companies have their origins in the privatisation of the state farms. At the beginning of the process, the assets of state farms were leased to small groups of people, usually including the former farm managers (Ratinger and Rabinowicz, 1997). Gradually, the non-land assets were sold to these lessees at favourable conditions with rescheduled payments. Hence the managers of these companies had some managerial experience from the pre-reform period and access to machinery from the previous state farms at

Table 1
Empirical studies of farm efficiency in the CEECs and the methodologies employed

Country	Author(s)	Dataset	Sample size	Methodology	Comments
Bulgaria	Mathijs and Vranken (2000)	1998 ACE survey	93	Data envelopment analysis (DEA)	Specialist crop farms only ^a
Czech Republic	Hughes (1998)	VUZE panel 1996	411	Tornqvist-Theil TFP Index	
Czech Republic	Mathijs and Swinnen (2000)	Agrocensus and VUZE panel data for 1996	227	DEA	
Czech Republic	Curtiss (2000)	VUZE FADN 1996–1998	95 wheat farms, 70 rapeseed & 43 sugar beet	Stochastic Frontier Analysis (SFA)	Wheat, rape seed and sugar beet only
Hungary	Hughes (2000a,b)	AKII 1996–1997	153 (1997)	Tornqvist-Theil TFP Index	
Hungary	Mathijs and Vranken (2000)	1998 ACE survey	178 crop and 77 dairy	DEA	Specialist crop and dairy farms only ^a
Poland	van Zyl et al. (1996)	1993 IERiGZ data	248	TFP and DEA	Two regions. Individual farms above 3ha only
Poland	Munroe (2001)	1996 IERiGZ data	1200	Cobb–Douglas stochastic frontier	Individual farms only
Slovakia	Mathijs et al. (1999)	1996	151	DEA	Producer co-ops & companies only
Slovakia	Morrison (2000)	1994–1996	30–39	SFA	Frontiers constructed for 7 products. Co-ops only
Slovakia	Hughes (2000b)	1990/1–1996	80	Tornqvist-Theil TFP Index	Only covered producer co-operatives
Slovenia	Brümmer (2001)	1995/6 FADN data	147 useable	SFA and DEA	Specialist horticulture excluded

^a Specialist dairy and crop farms defined as enterprises for which cow milk or grain production accounted for more than 50% of the total value of agricultural output.

favourable conditions. Yet most of this machinery was old, and therefore, burdened the companies with high replacement costs. The limited liability companies also accumulated liabilities to the state for acquiring assets from the former state farms. This might have impeded their access to credit. Thus, due to their different histories, the emerging farm structures in CEECs have different constraints and different qualities of management, which makes the assumption that farms use the same technologies highly questionable. In addition, there is some evidence that individual farms face different factor and output prices and therefore use different technologies (Meurs, 2001). Therefore, it is not surprising that only a few of the reviewed studies have used a production frontier approach.

More often, non-parametric approaches have been applied. DEA does not require arbitrary assumptions about the functional forms and the distribution of the error term. In essence, DEA uses a linear programming

procedure to minimise inputs per unit of output to determine the frontier of best-practice firms, and then to determine the efficiency of each production unit relative to their frontier (Ali and Seiford, 1993). The main reasons for its wide use are computational ease and the possibility of isolating scale efficiency from technical and allocative efficiency.

Two issues have pre-occupied researchers studying farm efficiency during the first years of transition: First, whether there is systematic evidence about the superiority of one or another management form, and particularly whether individual farms are more efficient than the co-operatives; and second, whether the individual farms created as a result of land restitution have been too small and exhibited scale inefficiencies. DEA, given that it allows for the separation of scale and pure technical efficiency effects, has been perceived as an adequate approach these questions. Another advantage of DEA in comparison to

Table 2
Summary of frontier efficiency analysis for Hungarian agriculture

Year	Deterministic		Stochastic		Non-parametric	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
1985	0.669	0.094	0.865	0.075	0.843	0.115
1986	0.628	0.086	0.989	0.046	0.803	0.120
1987	0.637	0.093	0.946	0.012	0.788	0.117
1988	0.715	0.094	0.896	0.049	0.787	0.109
1989	0.499	0.084	NA	NA	0.599	0.138
1990	0.669	0.106	NA	NA	0.759	0.123
1991	0.478	0.097	NA	NA	0.763	0.137

Source: Piesse (1999).

the parametric approach is that it can handle multiple-output and multiple-input situations simultaneously and cases where inputs and outputs are quantified using different units of measurement (Thiele and Brodersen, 1999). However, DEA is based on a deterministic approach, so all deviations from the frontier are attributed to inefficiencies. Hence, the above mentioned ‘noisy’ data for transition economies might not be well-suited for DEA. Moreover, DEA estimates could be biased towards higher scores if the most efficient farms within the population are not contained in the sample. Thus, a certain overestimation of sample efficiency is possible.

Given these issues, some authors have advocated the application of index methods, using Malmquist or Tornqvist-Theil productivity indices (Piesse, 1999; Hughes, 2000a,b).¹ Indices allow the consideration of detailed data on inputs and outputs but by their very nature cannot be checked for consistency statistically. However, they are easy to calculate and analysis may be carried out on a small sample, and this has made them appealing to researchers studying economies in transition.²

In order to illustrate the importance of the above points when interpreting results derived by different methods, Table 2 shows the results of three efficiency frontier estimations based on 117 observations in Hungary. Efficiency measures constructed by

stochastic frontier are consistency higher than those derived from the deterministic one. The same is true for the non-parametric frontier, but the standard deviation is also higher. The numerical results of studies of farm efficiency in the CEECs should be interpreted accounting for the method of estimation.

4. Review of results

The empirical findings of the studies listed in Table 1 are grouped according to three topics mirroring the topics discussed in Section 2: farm size, farm structures and other factors. These are discussed in turn.

4.1. Variations between farm sizes

As expected from the arguments presented in Section 2, the clearest finding on the size-efficiency relationship is that there does not appear to be a uniform, cross-national ‘optimum’ farm size. This is based on studies that in the majority of cases have used hectares managed as a measure of farm size. An exception to this has been for livestock farming where the value of total assets or total output has been applied (Mathijs and Vranken, 2000; Hughes, 2000b). None of the studies have measured size in terms of ESUs or controlled for farm fragmentation and differences in plot sizes.

For arable farming, in the Czech Republic there appear to be economies of size up to 750 ha, in Slovakia economies of scale persist above 2000 ha,³ while in

¹ Under the assumption of constant returns to scale, the latter is calculated as a geometric mean of two Malmquist indices (Caves et al., 1982).

² When Farm Accountancy Data Network (FADN) procedures were introduced in the EU applicant countries, they were based on small samples. For example, the FADN survey began in Hungary in 1996 with a sample of just 42 farms (Hughes, 2000b).

³ TFP analysis by Hughes (2000b) and the scholastic frontier analysis by Morrison (2000) obtained very similar results for Slovakia.

Table 3
Empirical evidence on variations in efficiency by farm size

Country	Author(s)	Findings
Czech Republic	Hughes (1998)	Economies of scale up to 750 ha for arable farming and up to 1,000,000 CZK in 1996 for livestock farms
Czech Republic	Curtiss (2000)	On average farms above 150 ha perform better for wheat and rapeseed production
Hungary	Hughes (2000b)	Diseconomies of scale over 500 ha, but variation could be accounted for by structural factors rather than size per se. Small private farms (up to 10 ha) perform remarkably well
Poland	van Zyl et al. (1996)	Larger private farms (above 15 ha) are in general less efficient although results are sensitive to the methodology employed
Poland	Munroe (2001)	Farms greater than 15 ha were less efficient
Slovakia	Morrison (2000)	For all commodities analysed, a positive relationship between the scale of production and level of efficiency is observed
Slovakia	Hughes (2000b)	Strong evidence of economies of size in crop production (best performing farms over 2000 ha). No evidence of economies of size in livestock production. Small farms' relative productivity improved over the period 1991–1996

Hungary diseconomies of scale appear to set in above 500 ha (Table 3). For Poland, van Zyl et al.'s (1996) analysis indicated that farms which are relatively large by Polish standards (above 15 ha) were, on average, less efficient for the year of study (1993) than their smaller counterparts. While the van Zyl et al. (1996) study is outdated, Munroe (2001) using data from 1996 also found that farms greater than 15 ha exhibited lower efficiency.

The van Zyl et al. (1996) study also illustrates how results may differ according to the methodology applied. Their TFP results indicate that large farms are not more efficient than smaller farms, particularly those within the 10–15 ha range and in fact a downward sloping curve for TFP with respect to farm size was observed (van Zyl et al., 1996). The DEA analysis, however, found insignificant differences between the mean sizes of scale efficient (SE) and inefficient farms ($P < 0.10$), as well as for the different farm size categories. The results for allocative efficiency (AE) were similar, yielding no significant differences. On the other hand, large farms (>15 ha) were significantly ($P < 0.10$) less technically efficient (TE) than smaller farms, but in terms of total efficiency ($SE \times TE \times AE$) large farms (>15 ha) did not differ significantly from smaller farms (van Zyl et al., 1996). The differences between the results obtained by the two approaches may be attributed to inherent differences in methodology. While DEA isolates scale

efficiency from technical and allocative efficiency, TFP measurements do not differentiate between them.

The discussion of the lack of economies of size for Poland by Munroe (2001) and van Zyl et al. (1996) is based on a dichotomy of small and large farms with 15 ha set as the threshold. This is an arbitrary distinction, as criticised by Doran (1985) and in one of the regions studied by van Zyl et al. (1996) no farm exceeded 54 ha. By Czech and Slovakian standards, all farms in this Polish region are 'small' and it is not possible to say whether economies of size exist outside the range of farm sizes provided in the Polish samples.⁴ This illustrates how size is a relative concept.

Notwithstanding these sampling issues, Hughes (2000b) argues that cross-national differences are linked to variations in the institutional environment for, and social capital of, small-scale farming. In Poland and Hungary small-scale farming was relatively more important during the communist era (especially in Poland) and more conducive support structures were developed in these countries. Hungary has had a much more supportive environment for small-scale private farming dating back to the New Economic Mechanism, and since 1989 has embarked on a more wholesale decollectivisation than the former Czechoslovakia, creating a larger, more well

⁴ Curtiss (2000) uses a threshold of 150 ha for classifying 'small' and 'large' farms in the Czech Republic.

supplied market for small farm inputs and services. The availability of external services for crop production, such as harvesting services and inputs for small farms, has historically been far better developed in Hungary and Poland. The availability of such services is seen as an important means of overcoming some of the sources of diseconomies of size (Hughes, 2000b). In the Czech Republic and Slovakia, far less land is operated by small farms and the market for supplying them with inputs and services is smaller and less well developed. Small-scale farms created by restitution in the Czech Republic and Slovakia are principally new phenomena. In the latter two countries it is expected that accumulated appropriate human and social capital in small-scale farming is also smaller than in Hungary and Poland. Where small, private farms are well established and managed continuously by the present farm household, they appear to be less inefficient relative to larger cohorts than in countries where small farms are a relatively new phenomenon. However, one must note the time frame of these studies. The data used by Brümmer (2001); Curtiss (2000); Hughes (2000b); Mathijs et al. (1999) and Munroe (2001) was from the mid-1990s. van Zyl et al. (1996) use data from 1993. It may be that as new owners become more

experienced or sell their land to more efficient farmers and the former large state and collective farms adopt a more professional management approach, some of these country variations, which have their origins in pre-transition farm structures, will diminish.

In their analysis of economies of size, the majority of authors do not control for differences in soil quality or other environmental factors (e.g. Mathijs and Swinnen, 2000; Mathijs et al., 1999; van Zyl et al., 1996, Curtiss, 2000). In most cases this has been due to lack of data, but where soil quality and altitude have been measured they have proved significant. For example, Brümmer (2001) found that Slovenian farms 600 m above sea level displayed lower technical efficiency and these 'high altitude' farms are on average larger.

4.2. *Variations between structures*

The most striking feature of the research on farm structures and productivity is that the evidence is far from clear cut (Table 4). In Hungary, when other factors are controlled for, family farms do appear to be more efficient, based on both Tornqvist-Theil TFP Indices and DEA analysis (Hughes, 2000a; Mathijs

Table 4
Empirical evidence on variations in efficiency by farm structure

Country	Author(s)	Findings
Bulgaria	Mathijs and Vranken (2000)	For crop production, companies performed better than family farms (although based on a very small sample). The share of insiders has a positive influence on the technical efficiency of co-operatives
Czech Republic	Hughes (1998)	Individual private farms were significantly more productive for livestock, but not crop farming. Co-operatives performed better than farming companies
Czech Republic	Mathijs and Swinnen (2000)	For animal breeding and dairy farming, family farms were more efficient than co-operatives and companies. For crops no significant differences between co-operatives and companies are observed. Co-operatives were found on the production technology frontier of all specialisations
Czech Republic	Curtiss (2000)	Co-operatives performed better than individual farms and companies except for sugar beet where individual private farms performed best. The latter are more labour intensive but geographically dispersed
Hungary	Hughes (2000b)	Individual private farmers had significantly higher TFP scores than any other farm type
Hungary	Mathijs and Vranken (2000)	For crop farming, while all three structures investigated (family farms, companies, co-operatives) could be technically efficient, on average family farms were best with companies performing better than co-operatives
Slovakia	Mathijs et al. (1999)	Family farms performed best except for mixed crop-dairy farms where companies and co-operatives were more scale efficient

and Vranken, 2000), but no such relationships hold in Bulgaria. For the Czech Republic, both Hughes (1998) and Mathijs and Swinnen (2000) found that individual private farms were significantly more productive than corporate farms in livestock farming but not in crop production. In Curtiss' (2000) analysis of crop production in the Czech Republic she found that co-operatives performed better in wheat and rapeseed cultivation compared to individual farms but that the latter were superior in sugar beet production. In Slovakia family farms appear to be more efficient in the specialist livestock sector but not for combined dairy and crop production (Mathijs et al., 1999).

Comparatively assessing these results, it appears that arguments that co-operatives or other forms of corporate farming are inherently less efficient, for all types of farming, than family farms are misplaced. Even where the average corporate farm is less productive than the average family farm, one still sees some co-operatives and companies which are on the frontier or registering high TFP scores (Hughes, 2000a; Mathijs and Vranken, 2000). In explaining why there appear to be significant differences in efficiency between corporate farms and family farms for certain activities and not others, Mathijs and Vranken (2000) follow the propositions of Allen and Lueck (1998). They argue that governance problems in corporate farms will be most severe where production is spatially diffused and sequential, as in these cases the costs of supervising and monitoring hired labour are highest (e.g. arable farming). Mathijs et al. (1999) and Mathijs and Vranken (2000) argue that this explains why family farms in the Czech Republic, Hungary and Slovakia appear more efficient for crop production but such advantages disappear in the dairy sector. It should be noted, however, that Curtiss (2000) finds no such advantages for family farms in wheat or rapeseed production. In her stochastic frontier analysis, individual farms were only for sugar beet production seen to be more efficient. She argues that this result might be due to sugar beet production being more labour intensive so that only in this case are the advantages of family farms in the supervision of labour significant.

Hughes (2000b) takes a different approach in arguing why the performance of corporate farms has been better than some of the initial assumptions made about them would have led one to suppose. He argues that while in the pre-reform period co-operatives

and state farms were beset by low labour effort, free-riding problems and principal-agent difficulties, these have now been much reduced by changes in the external environment and internal structures. Worker bargaining power has been reduced by the presence of high rural unemployment, so that whereas previously villagers could hold on to a co-operative job irrespective of work effort, today the costs of being caught shirking and being dismissed are far higher. Political developments in the Czech and Slovak Republics have also reduced worker bargaining power in the general assemblies of co-operatives so that decisions are no longer guaranteed to be made on the basis of one member one vote (Hughes, 2000a).⁵ In this environment as the marginal productivity of labour is higher, managers have a greater ability to detect and resist free riding by farm workers (Hughes, 2000a). From this viewpoint many of the governance problems attributed to corporate farms are not seen as being inherent to this structure per se, but were rather generated by the external environment in which they operated before transition. On these grounds, and given the empirical evidence from other studies, one should not expect non-family farms to disappear in the region or to be inherently less competitive, although one may see greater specialisation into activities in which labour supervision and monitoring is less costly.

4.3. *Evaluation of other factors*

The majority of farm efficiency studies for the region have focused on size and structural matters. Both the dominance of size and structural issues in policy debates and the availability of data have influenced this. Most previous studies have used farm accounting records that do not contain information on human and social capital. This is unfortunate given that, where investigated, human and social capital appear to be significantly related to farm efficiency (Lockheed et al., 1980; Stefanou and Saxena, 1988). The consideration of human capital-efficiency effects is of particular importance for the CEECs as the level of formal education and training held by small-scale farmers in the region tends to be low.

⁵ Hungary's 1992 Co-operative Transformation Law also weakened the bargaining power of workers as the requirement that co-operatives had to provide jobs for all members was removed.

Table 5
Empirical evidence on variations in efficiency accounted for by other factors

Country	Author(s)	Findings
Bulgaria	Mathijs and Vranken (2000)	Strong relationship between education and technical efficiency for dairy and crop production. Positive relationship with contracting
Czech Republic	Hughes (1998)	Significant regional variation (mountainous farms registered the worst performance)
Hungary	Mathijs and Vranken (2000)	Strong relationship between education and technical efficiency for dairy and crop production. Share of women in the household has a positive effect but only significantly so for crop farms. Farms that have bought land are more efficient. Contracting was positively related with technical efficiency especially for crop farming
Poland	Munroe (2001)	Positive relationship between efficiency and both experience (age of farmer) and farm modernisation (measured as use of electricity and gas heating)
Slovenia	Brümmer (2001)	Lower efficiency associated with higher altitude (>600 m above sea level) and part-time farming

Some attempts, however, have been made to investigate other agency and structural factors affecting farm efficiency (Table 5). In both Bulgaria and Hungary, Mathijs and Vranken (2000) found a significantly positive relationship between education and technical efficiency in family farms for both crop and dairy farming, where education was measured as years spent in formal education. However, the evidence on other aspects of human capital was less clear. For example, age had a positive impact on the efficiency of Hungarian crop farms, as it did in Munroe's (2001) analysis for Poland, but a negative relationship was recorded for Bulgaria. Both of these studies found no significant relationship between efficiency and the number of women in the household. Mathijs and Vranken (2000) found that the share of the workforce aged over 60 years has a significant influence on technical efficiency in dairy farming but not arable. This evidence points to the importance of human capital, but not all the dimensions of this are clearly understood. Even in the case of the relationship between technical efficiency and education there is a need to distinguish between agricultural and non-agriculturally specific education to see to what extent career-specific skills or the stimulation of wider key skills (or a combination of both) are important.

Mathijs and Vranken's (2000) other main finding concerns the relationship between technical efficiency and contracting. They found that contracting was significantly related to higher technical efficiency especially for crop production. Contracting has been seen as a means of overcoming imperfections in credit markets where downstream processors provide credit

or physical inputs combined with technical advice and information (Gow and Swinnen, 1998). However, it may (also) be that upstream processors purposely select farms they know as being 'good', and as the Mathijs and Vranken (2000) study offers a snapshot it is not possible to draw conclusions regarding the causality of the relation between contracting and efficiency. In investigating on-farm factors, Munroe (2001) found a positive relationship between farm modernisation (measured as the use of electricity and gas heating) and technical efficiency for Poland. Brümmer (2001) tests for differences in technical efficiency between part and full-time farms in Slovenia. He found that full-time farms are more efficient and this is interpreted as reflecting that part-time farmers have lower opportunity costs for labour and certain types of capital as a result of quality differences and the 'hobby' character of some part-time farms. Only Brümmer (2001) tests for differences between full and part-time farms, and this is unfortunate given that decollectivisation has created a mass of new, small units and in countries which were not extensively collectivised (such as Poland and Slovenia) small-scale farming still prevails.

Finally, reviewing all the studies it should be noted that the evidence presented is biased towards the Central European countries. Looking at the applicants for EU membership, there is a lack of evidence on the Baltic States and Romania. This matters because the findings to date show considerable differences between countries, especially regarding the importance of the institutional environment. A critical issue

in this regard is the nature of a country's marketing environment for small farms.

5. Conclusions

A recent World Bank paper on the CEECs argues that "production co-operatives have consistently failed to demonstrate competitiveness with private family farms" and that there is "no evidence in favour of economies of scale in farming, rather the opposite" (World Bank, 1998, p. 6). The review in this paper of factors affecting efficiency and of the empirical findings from the CEECs point to more complex conclusions.

The majority of studies on arable farming have found evidence of economies of size and these may extend above the typical size of contemporary family farms in the region. However, these conclusions are largely based on studies that do not control for variations in human capital and agri-environmental factors. Previous research on developing countries has indicated that these factors are important 'missing variables' which, when controlled for, may substantially weaken previous assumptions made about the role of size. Path dependency factors appear to play a role and small farms appear to be relatively more efficient in countries where support services for small-scale farms are better developed.

Some authors have advocated the amalgamation of small farms to realise economies of size in the region (Curtiss, 2000). While amalgamation may aid technical and allocative efficiency in certain cases, such appeals tend to often ignore the nature of decision making in, and the dynamics of, peasant households (Ellis, 1988). A more fruitful approach may be consider ways of improving service provision (especially mechanisation services) to small-scale farms that reduce some of the diseconomies of small farm sizes. Small-scale agriculture in the CEECs does not appear to be a temporary phenomenon and the rate of structure change in Poland, where small farms predominate, has been modest (Safin and Guba, 2000). Improving the institutional environment for small farms will be more beneficial than appeals for farm amalgamation.

Regarding the economics of farm structures there is no clear cut evidence of corporate farms being inherently less efficient, for all farming activities, than

family farms. Where significant differences have been found in favour of family farms against the average corporate farm, the best corporate farms still tend to perform as well as the best family farms (Hughes, 2000b). One should not expect corporate farms to always be unable to compete, and many will survive and thrive in the future. However, at a commodity level, corporate farming appears most suited to activities in which production is spatially concentrated or labour represents a smaller proportion of costs (Curtiss, 2000; Mathijs and Swinnen, 2000). Corporate farms are also likely to perform better where the costs of being caught shirking are higher (i.e. managers have the ability to dismiss free-riding workers or high rural unemployment acts as deterrents).

While size and structural effects have been investigated by a number of authors, there has been comparatively little research on the linkages between the human and social capital of CEEC farmers and technical efficiency. Mathijs and Vranken (2000) did find a significant relationship between years of education and farm efficiency. The educational level of farmers in the region has given cause for concern. For example in Poland, 59% of those employed mainly or exclusively on individual farms in 1998 had, at most, only primary education, and of these over 8% had not even completed primary school (Safin and Guba, 2000). Under one-sixth (14%) had completed secondary education and just 1% had completed university. Those employed in farming have tended to see their incomes fall relative to national and rural averages during transition and many suffer from a lack of the skills demanded on non-agricultural labour markets. The question of how to improve human capital in rural areas both to improve farm efficiency and to aid diversification out of farming remains pressing.

Another area for future research is the relationship between farm efficiency and non-agricultural activities. Previous studies have focused almost exclusively on the agricultural activities of farms but there is evidence of widespread diversification of both individual and corporate farms (Davis and Pearce, 2000). Understanding the linkages between farm efficiency and non-agricultural activities is important, as studies on developing countries have shown (Savadogo et al., 1994).

Finally, one should note that cross-national comparisons have been limited by differences in data

collection procedures between countries (especially the allocation of fixed costs) and, in some cases, access to data. While most associated countries are harmonising their own surveys with the EU's FADN, this has taken longer than initially envisaged (AKII, 2000). It is therefore difficult to use the results of efficiency studies directly, compare performance between CEECs and existing EU member states. While one is able to identify farms which are relatively more efficient (e.g. on the production frontier or with a higher TFP index score) in a particular sample for one CEEC, the frontier for that country might bear little relationship to what is internationally efficient. However, from the efficiency studies already conducted one can conclude that a more nuanced set of conclusions concerning the farm size, structure and efficiency debate should be drawn than was present in many of initial pronouncements on decollectivisation.

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References

- Aigner, D., Lovell, C., Schmidt, P., 1977. Formulation and estimation of stochastic frontier production function models. *J. Econometrics* 6, 21–37.
- AKII, 2000. The development of FADN in Hungary. *Agrárgazdasági Kutató és Informatikai Intézet*, Budapest.
- Ali, A., Seiford, L., 1993. The mathematical approach to efficiency analysis. In: Fried, H., Lovell, K., Schmidt, S. (Eds.), *The Measurement of Productive Efficiency, Techniques and Applications*. Oxford University Press, Oxford, pp. 120–159.
- Allen, D., Lueck, D., 1998. The Nature of the Farm. *J. Law Econ. XLI* (October 1998), 343–386.
- Barrett, C.B., 1998. On price risk and the inverse farm size-productivity relationship. *J. Develop. Econ.* 51, 193–215.
- Benjamin, D., 1995. Can unobserved land quality explain the inverse productivity relationship? *J. Develop. Econ.* 1, 51–84.
- Bhalla, S., Roy, P., 1988. Mis-specification in farm productivity analysis: the role of land quality. *Oxford Econ. Pap.* 1, 55–73.
- Bharadwaj, K., 1974. *Production Conditions and Indian Agriculture*. Cambridge University Press, Cambridge.
- Binswanger, H., Elgin, M., 1998. Reflections on land reform and farm size. In: Eicher, C., Staatz, J. (Eds.), *International Agricultural Development*, third ed. Johns Hopkin, Baltimore, pp. 316–328.
- Binswanger, H., Deininger, K., Feder, G., 1993. Agricultural land relations in the developing world. *Am. J. Agric. Econ.* 5, 1242–1248.
- Brem, M., 2000. Getting rid of organizational legacy—what costs restructuring of the Czech agricultural production. Paper Presented at the KATO Symposium Berlin, Germany, November 2–4th.
- Brem, M., Kim, J.-M., 2000. The status of agricultural producer co-operatives in East European Countries. *Korean J. Int. Agric.* 3, 238–256.
- Brümmer, B., 2001. Estimating confidence intervals for technical efficiency: the case of private farms in Slovenia. *Eur. Rev. Agric. Econ.* 28, 285–306.
- Buckwell, A., Davidova, S., 1993. Potential implications for productivity of land reform in Bulgaria. *Food Pol.* 6, 493–506.
- Carter, M., Wiebe, K., 1990. Access to capital and its impact on agrarian structure and productivity in Kenya. *Am. J. Agric. Econ.* 5, 1146–1150.
- Caves, D.W., Christensen, L.R., Diewart, E.W., 1982. The economic theory of index numbers and the measurement of input, output, and productivity. *Econometrica* 50, 1393–1414.
- Coelli, T., Rao, P., Battese, G., 1998. *An Introduction to Efficiency and Productivity Analysis*. Kluwer Academic Publishers, Norwell, Massachusetts.
- Cornia, G., 1985. Farm size, land yields and the agricultural production function: an analysis of fifteen developing countries. *World Develop.* 4, 513–534.
- Cristoiu, A., 2001. Technical Efficiency and its Determinants in Romanian Farming during Transition. Imperial College at Wye, unpublished, mimeo.
- Csaki, C., Lerman, Z., 1996. Agricultural Transformation in Central and Eastern Europe and the Former USSR: Issues of Land Reform and Farm Restructuring. Paper Presented at the VIIIth Congress of the European Association of Agricultural Economists, Edinburgh.
- Curtiss, J., 2000. Technical Efficiency and Competitiveness of the Czech Agricultural Sector in Late Transition—The Case of Crop Production. Paper Presented at the KATO Symposium Berlin, Germany, November 2–4th.
- Davidova, S., Gorton, M., Ratering, T., Zawalinska, K., Iraizoz, B., Kovacs, B., Mizik, T., 2002. An Analysis of Competitiveness at Farm Level in CEECs. EU FP5 IDARA Project, Working Paper Series, Working paper 2/11, Imperial College at Wye.
- Davis, J., Pearce, D., 2000. The Rural Non-Farm Economy in Central and Eastern Europe. NRI Rural Non-Farm Economy Project, Chatham, Discussion Paper No. 00/01.
- Dawson, P., Hubbard, L., 1987. Management and size economies in the England and Wales dairy sector. *J. Agric. Econ.* 1, 27–37.
- Doran, H.E., 1985. “Small” or “large” farm: some methodological considerations. *Am. J. Agric. Econ.* 1, 130–132.
- Ellis, F., 1988. *Peasant Economies: Farm Households and Agrarian Development*. Cambridge University Press, Cambridge.
- Evans, D., 1987. Empirical analysis of the size distribution of farms: discussion. *Am. J. Agric. Econ.* 2, 484–485.
- Gorton, M., Davidova, S., 2001. The international competitiveness of CEEC agriculture. *World Econ.* 2, 185–200.

- Gow, H., Swinnen, J., 1998. Up- and downstream restructuring, foreign direct investment, and hold-up problems in agricultural transition. *Eur. Rev. Agric. Econ.* 3, 331–350.
- Gow, H., Swinnen, J., 2001. Private capital and contract enforcement in transitional economies. *Am. J. Agric. Econ.* 3, 686–690.
- Hagedorn, K., 1994. Changing Organisation of Agriculture as a Result of the Transformation Process. Paper Presented at the Workshop The Impact of CEE Agricultural Reform on Domestic and International Markets, Leuven, 10–11th June.
- Hall, B., LeVein, P., 1978. Farm size and economics efficiency: the case of California. *Am. J. Agric. Econ.* 4, 589–600.
- Hughes, G., 1998. Agricultural Productivity and Farm Structure in the Czech Republic. EU FAIR Project Agricultural Implications of CEEC Accession to the EU. Working Paper Series, Working Paper 2/7, Wye College, University of London.
- Hughes, G., 2000a. Total productivity of emergent farm structures in Central and Eastern Europe. In: Banse M., Tangermann, S. (Eds.), *Central and Eastern European Agriculture in an Expanding European Union*, CABI, Walingford, pp. 61–87.
- Hughes, G., 2000b. Agricultural Decollectivisation in Central Europe and the Productivity of Emergent Farm Structures. Ph.D. Thesis, Wye College, University of London, unpublished, mimeo.
- Johnson, N., Ruttan, V., 1994. Why are Farms so Small? *World Develop.* 5, 691–706.
- Kanchev, I., 2000. Agrarian structures in Bulgarian- problems and development. In: Tillack P., Pirscher, F. (Eds.), *Competitiveness of Agricultural Enterprises and Farm Activities in Transition Countries*. Wissenschaftsverlag Vauk, Kiel, pp. 205–213.
- Kislev, Y., Peterson, W., 1996. Economies of scale in agriculture: a re-examination of the evidence. In: Antle, J., Simner, D. (Eds.), *Essays on Agricultural Economics in Honor of D. Gale Johnson*, vol. 2. University of Chicago Press, Chicago.
- Koester, U., Striewe, L., 1999. Huge potential, huge losses—the search for ways out of the dilemma of Ukrainian agriculture. In: Siedenberg, A., Hoffman, L. (Eds.), *Ukraine at the Crossroads: Economic Reforms in International Perspective*. Physica-Verlag, New York, pp. 257–270.
- Lansik, A., 2000. Productivity growth and efficiency measurement: a dual approach. *Eur. Rev. Agric. Econ.* 1, 59–73.
- Lockheed, M.E., Jamison, D.T., Lau, L.J., 1980. Farmer education and farm efficiency. *Econ. Develop. Cultural Change* 1, 37–76.
- Lund, P., 1983. The use of alternative measures of farm size in analysis of size and efficiency relationship. *J. Agric. Econ.* 2, 187–189.
- Lund, P., Price, R., 1998. The measurement of average farm size. *J. Agric. Econ.* 1, 100–110.
- Mathijs, E., Blaas, G., Doucha, T., 1999. Organisational form and technical efficiency of Czech and Slovak farms. *MOCT-MOST: Econ. Policy Trans. Econ.* 3, 331–344.
- Mathijs, E., Swinnen, J., 1998. The economics of agricultural decollectivization in East Central Europe and the former Soviet Union. *Econ. Develop. Cultural Change* 1, 1–26.
- Mathijs, E., Swinnen, J., 2000. Technical efficiency and the competitiveness of agricultural enterprises: results from Eastern Germany and the Czech Republic. In: Tillack, P., Pirscher, F. (Eds.), *Competitiveness of Agricultural Enterprises and Farm Activities in Transition Countries*. Wissenschaftsverlag Vauk, Kiel, pp. 86–97.
- Mathijs, E., Vranken, L., 2000. Farm restructuring and efficiency in transition: evidence from Bulgaria and Hungary. Selected Paper, American Agricultural Economics Association Annual Meeting, Tampa, Florida, July 30–August 2.
- Mech, D.-M., 1999. The Survival of Peasant Agriculture in Poland. Ph.D. Thesis. Wye College, University of London, unpublished, mimeo.
- Meeusen, W., van den Broeck, J., 1977. Efficiency estimation from Cobb–Douglas production function with composed error. *Int. Econ. Rev.* 18, 435–444.
- Meurs, M., 2001. The evolution of Agrarian institutions: A Comparative Study of Post-Socialist Hungary and Bulgaria. University of Michigan Press, Ann Arbor.
- Morrison, J., 2000. Resource Use Efficiency in an Economy in Transition: An Investigation into the Persistence of the Co-operative in Slovakian Agriculture. Ph.D. Thesis, Wye College, University of London, unpublished, mimeo.
- Munroe, D., 2001. Economic efficiency in Polish peasant farming: an international perspective. *Regional Stud.* 5, 461–471.
- Nguyen, T., Cheng, E., Findlay, C., 1996. Land fragmentation and farm productivity in China in the 1990s. *China Econ. Rev.* 2, 169–180.
- Piesse, J., 1999. Efficiency Issues in Transitional Economies: An Application to Hungary. Ashgate, Aldershot.
- Pollak, R., 1985. A transaction cost approach to families and households. *J. Econ. Lit.* 23, 581–608.
- Ratinger, T., Rabinowicz, E., 1997. Changes in farming structures in the Czech Republic as a result of land reform and privatisation. In: Swinnen, J., Buckwell, A., Mathijs, E. (Eds.), *Agricultural Privatization, Land Reform and Farm Restructuring in Central Europe*. Ashgate, Aldershot, pp. 80–99.
- Rizov, M., Mathijs, E., Swinnen, J., 2001. The role of human capital and market imperfections in labor allocation in transition economies: theory and evidence from Hungary. American Agricultural Economics Association Annual Meeting, Chicago, Illinois.
- Roumasset, J., 1995. The nature of the agricultural firm. *J. Econ. Behav. Org.* 26, 161–177.
- Safin, M., Guba, W., 2000. Rural development and rural labour markets in Poland, EU Network of Independent Agricultural Experts in the CEEC Candidate Countries. Issue Paper No. 5, Warsaw.
- Sau, R.K., 1973. *Indian Economic Growth: Constraints and Prospects*. Orient Longman, New Delhi.
- Savado, K., Reardon, T., Petiola, K., 1994. Farm productivity in Burkina Faso: effects of animal traction and nonfarm income. *Am. J. Agric. Econ.* 3, 608–612.
- Schmitt, G., 1991. Why is the agriculture of advanced Western countries still organised by family farms? Will this continue to be so in the future? *Eur. Rev. Agric. Econ.* 3, 443–458.
- Schmitt, G., 1993. Why collectivisation of agriculture in socialist countries has failed: a transaction cost approach. In: Csaki, C., Kislev, Y. (Eds.), *Agricultural Cooperatives in Transition*. Westview Press, Boulder, pp. 143–159.

- Seckler, D., Young, R., 1978. Economic and policy implications of the 160-Acre limitation in Federal Reclamation Act. *Am. J. Agric. Econ.* 4, 575–588.
- Sumner, D., Leiby, J., 1987. Analysis of the effects of human capital on size and growth among dairy farms. *Am. J. Agric. Econ.* 2, 465–470.
- Stefanou, S., Saxena, S., 1988. Education, experience and allocative efficiency: a dual approach. *Am. J. Agric. Econ.* 2, 338–345.
- Swain, N., 1998. Agricultural restitution and co-operative transformation in the Czech Republic, Hungary and Slovakia. *Europe-Asia Stud.* 7, 1199–1219.
- Thiele, H., Brodersen, C., 1999. Differences in farm efficiency in West and East Germany. *Eur. Rev. Agric. Econ.* 3, 331–347.
- van Zyl, J., Miller, W.R., Parker, A.N., 1996. Agrarian Structure in Poland: The myth of large farm superiority. The World Bank, Washington, DC.
- Verma, B., Bromley, D., 1987. The political economy of farm size in India: the elusive quest. *Econ. Develop. Cultural Change* 4, 791–808.
- Welch, F., 1970. Education in production. *J. Political Econ.* 1, 35–59.
- Williamson, O., 1988. The logic of economic organization. *J. Law, Econ. Org.* 4, 65–117.
- World Bank, 1998. Rural Development in Eastern Europe and Central Asia: Progress To Date and Strategic Directions For ECA, Internal Document, June 16, 1998, <http://wbln0018.worldbank.org/Networks/ESSD/icdb.nsf>.