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Employment and Efficiency of Farms in Transition: an Empirical Analysis for Brandenburg

INTRODUCTION

Changes in the political, economic and legal framework after reunification led to major structural changes in East German agriculture. Altered factor and product price relations, abolition of traditional channels of distribution and problems with liquidity forced existing farms to adjust their organization and factor input, to increase productivity and to seek technical progress. Although the number of agricultural enterprises has grown continually as a result of the appearance of new and re-established farms, the number of people engaged in agriculture has fallen dramatically. In Brandenburg – the federal state surrounding Berlin – 31 per cent of those employed in agriculture in 1990 were forced into early retirement, and another 20 per cent took part in further education, retraining or employment creation schemes (MELF, 1997). Many of those workers who had been engaged in employment creation schemes became unemployed after completion. Even from 1992 to 1997, the workforce in agriculture decreased from 39 055 to 25 991 working units (WU).

The paper attempts to study the factors that have determined the employment decisions of farm operators and how they adjusted employment over time with particular regard to legal forms and production structures. This is achieved by applying a data envelopment analysis to a sample of 89 farms, existing over the period 1992/93 to 1995/96. The article is structured as follows. After presenting the theoretical background of labour deployment in enterprises undergoing transition, some hypotheses are developed as a guideline for the empirical investigation. The next section describes the method and the data which are utilized and that is followed by presentation and discussion of the empirical results.

THEORETICAL BACKGROUND

The annual Agricultural Report of the German Federal Government (*Agrarbericht*) draws attention to two interesting phenomena relating to the successors of the former agricultural production cooperatives (LPGs). Firstly,

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those farms which are organized as legal entities operate at a significantly higher labour intensity than the new and re-established East German family farms and partnerships. Secondly, on average, profits are slightly negative for most financial years and regions. On the one hand, this may be understood to be a symptom of the general inefficiency of what are usually large farms mainly operating with hired labour. Proponents of transaction cost theory argue that the employment of hired non-family labour causes agency and monitoring costs which diminish existing economies of scale; moreover, cooperatives in particular are confronted by a 'free-rider' problem (Peter and Weikard, 1993; Beckmann, 1997; Schmitz and Noeth, 1999). Both aspects are regarded as being of considerable relevance for agriculture where production is based on natural processes that include seasonality and randomness (Allen and Lueck, 1999).

On the other hand, Balmann *et al.* (1996) provide two alternative explanations. Firstly, these successors are affected by significant sunk costs resulting from investments prior to the transition period. Dairy and pig farms, in particular, started transition with buildings whose opportunity costs were usually low. If an asset's costs are truly 'sunk', it is more than the use of the asset itself that can be affected. According to Johnson (1972), sunk costs of one factor also affect the use of other complementary factors (such as labour), which may be employed to a greater extent than when there is perfect mobility of all factors. Figure 1 depicts this effect. Considering productivity P and labour input L, sunk costs for assets lead to a change in the relevant marginal productivity curve of labour input from $\partial P / \partial L$ to $\partial P' / \partial L$.[1] If the optimality condition for labour input for a wage w is $\partial P' / \partial L = w$ and $\partial P' / \partial L > \partial P / \partial L$, then sunk costs cause the optimal employment to rise from L^* to L'. According to Figure 1, that shift implies that a farm operating at L' is very likely to show decreasing returns to scale, particularly since for L' the average and the marginal productivity differ more than for L^*.

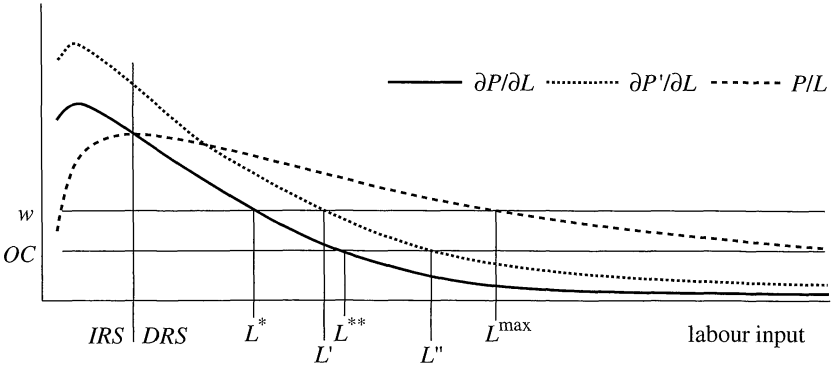

FIGURE 1 *Optimal deployment of labour, as dependent on sunk costs and labour costs*

Secondly, Balmann *et al.* (1996) hypothesize that cooperatively organized enterprises do not necessarily aim at profit maximization. For example, an enterprise where capital owners and employees are largely one and the same group may strive for an employment level that is not oriented to the wage w but rather to the employees' opportunity costs OC. The implication would be an increase of labour input from L^* to L^{**} and L' to L'', respectively. At that point the marginal labour productivity is equal to the workers' opportunity costs. A cooperative's strategy based on the opportunity costs of its members may, of course, be rational from the perspective of the whole group of members if it allows for internalizing pecuniary externalities caused by labour market distortions.[2] In the end, such a strategy has similar effects to those which Schmitt (1997), for example, considers to be relevant for family enterprises and which explain some interesting phenomena of family farm-dominated agriculture, notably persistent income disparities (Balmann, 1999). Moreover, whenever cooperative members and workers are an identical group, it does not appear implausible that cooperatives should aim for job maximization, as a result of their decision-making structures, since every member's vote has the same weight in the general meeting. This deviates from comparative – static approaches of analysing cooperative behaviour.

For example, Ward (1958) concludes that cooperatives maximize average productivity and thus show underemployment (cf. Weikard, 1996). If one assumes that capital depletion should not take place, the whole farm's capacity to pay for equity capital and labour input P may be used to pay wages. From the given wage rate w, the maximum level of employment L^{max} is reached where the average productivity P / L is equal to w.[3] Because there are no profits, this solution implies that capital provided by the members is not paid for.[4] Thus this solution only appears feasible in cases where the majority of members in a cooperative support the goal of job maximization, perhaps because job security is desired, or because of solidarity within the membership. In principle, if workers and shareholders are nearly identical and if shares are rather equally distributed, such goals could also be set by other legal forms of corporate farming (for example, limited liability enterprises). In fact, this is usually not the case; membership and employment structure differ depending on legal form (*Agrarbericht*, various years).

With regard to LPG successors burdened with so-called 'old debts', profit avoidance appears particularly plausible, because this simultaneously postpones the repayment of old debts. According to Forstner and Isermeyer (1997), legal entities without old debts performed much better and showed a lower labour intensity. These considerations suggest that empirical analysis might show that:

- efficiency in general and labour productivity in particular should, ceteris paribus, be lower for LPG successors than for newly and re-established farms;
- within the group of LPG successors efficiency should be lower (a) for farms with animal production than for cash crop farms, (b) for cooperatives than for other corporate farms, and (c) for farms with old debts;

- because the relevance of sunk costs decreases over time, the efficiency of successors should increase – particularly in animal production.

MODEL AND DATA

In order to shed some light on these aspects of the adjustment process, a data envelopment analysis (DEA) was applied to a sample of farms from Brandenburg (Germany). DEA is a non-parametric method of estimating a production frontier by means of linear programming.[5] It measures the relative performance of farms on the basis of Farrell's definition of efficiency, with a score between zero and one being attached to every farm appearing in the analysis. An advantage of this technique, exploited in the application, is that it easily accommodates multi-input/multi-output technologies. In particular, input-oriented models with constant and variable returns to scale are used. This approach allows us to distinguish between technical efficiency and scale efficiency and indicates whether a farm shows increasing or decreasing returns to scale. Furthermore, input slacks, that is, excess factor inputs, are reported for farms, which are located or projected on the vertical or horizontal axis of the production frontier.

The material for the empirical analysis is based on the farm accountancy network (FADN) of Brandenburg. A sample of 210 financial statements was drawn for the years from 1992/93 to 1995/96. Table 1 classifies the sample with respect to legal status, main production and financial year. Because of the low number of cases in some groups, general conclusions must be drawn carefully.

In DEA, all financial statements are analysed simultaneously in order to facilitate a comparison of different farm types, legal forms and financial years. This procedure can be justified by the fact that there were only moderate changes in prices and agricultural policies during the time period under consideration. Table 2 specifies the input and output variables which enter the DEA model.

Though capital, as a factor, can be expected to influence the efficiency results, this variable has not been included in the model at the present stage of analysis. Problems arise from a rather arbitrary evaluation of real assets used in the opening balances as well as from widely differing depreciation practices. Both facts cause serious distortions in the measurement of farm capital input.[6] The exclusion of the factor may underestimate economies of scale of large farms because of the cost-decreasing impact of large buildings and machines.

RESULTS AND INTERPRETATION

Efficiency results

Table 3 exhibits the average total efficiency values for the various farm types, legal forms and time periods under investigation.[7] According to Table 3,

TABLE 1 *The farm sample*

	1992/93				1993/94				1994/95				1995/96			
LF	All	CP	LF	MP	All	CP	LF	MP	All	CP	LF	MP	All	CP	LF	MP
NP	5	5			9	6	3		14	9	5		15	9	6	
LE	15	3	10	2	26	8	15	3	52	17	29	6	74	21	43	10
Coop	11	1	8	2	16	2	11	3	33	7	22	4	47	7	33	7
Other	4	2	2		10	6	4		19	10	7	2	27	14	10	3
Total	20	8	10	2	35	14	18	3	66	26	34	6	89	30	49	10

Notes: Legal form: NP – natural persons (family farms, partnerships); LE – legal entities; Coop – cooperatives. Farm type: CP – cash crop farm; LF – livestock farm; MP – mixed farms and pig farms. Cash crop (livestock) farms receive more than 50 per cent of standard farm income from cash crops (livestock).

TABLE 2 *Input and output variables of the DEA model*

Output variable	Unit	Definition	Input variable	Definition	Unit
y_1 Crop production	DM	Revenue from: – cash crops – change in stocks	x_1 Labour	Sum of working units per enterprise	WU
y_2 Animal production	DM	Revenue from: – animal products – increase/decrease in stock	x_2 Land	Worked land area in ha. weighted with the enterprise's average soil quality index	ha. * EMZ
y_3 Other	DM	Revenue from: – special business proceeds – subsidies	x_3 Variable inputs	Material costs for: – livestock – crop production – trade, services	DM

TABLE 3 *Evolution of average efficiency values (percentages)*

	Total efficiency: cash crop farms		Total efficiency: livestock farms		Scale efficiency		Relation IRS/DRS	
	Natural persons	Legal entities	Natural persons	Legal entities	Natural persons	Legal entities	Natural persons	Legal entities
1992/93	82	75	—	58	90	77	60 / 20	0 / 100
1993/94	85	75	93	62	93	78	56 / 11	8 / 92
1994/95	83	80	78	69	90	84	50 / 14	12 / 83
1995/96	85	77	85	71	93	83	40 / 13	9 / 88

Notes: *IRS – increasing returns to scale; DRS – decreasing returns to scale.*

'natural persons', that is, family farms and partnerships, reached an efficiency level of about 85 per cent irrespective of the farm type. In contrast, legal entities showed an efficiency level of 75 to 80 per cent for cash crop farming, while the level for animal farms rose gradually from 58 to 71 per cent.

Obviously, livestock farms that succeeded former LPGs required a much longer time to adjust to a more efficient resource use and technical productivity. This observation gives evidence for our initial thesis that sunk costs – which are particularly relevant for animal farming – have a strong impact on adjustment speed. An additional explanation for the delay in the catch-up-process, which holds for dairy farms, is the necessary, but time-consuming, replacement of traditional breeds by more productive types.[8] The higher efficiency of family farms and partnerships is plausible, since they normally started off with adequate production techniques. The same applies to corporate cash crop farms, which have better opportunities to incorporate technical progress as a result of rationalization investments and shorter investment cycles. As far as the evolution of efficiency of different legal forms is concerned, Mathijs and Swinnen (1997) arrive at a similar conclusion for all East German states. The only difference from our result is that they suggest there is a convergence of technical efficiency for all farm types, whereas our results indicate that in livestock production the technical efficiency of 'legal entities' is still lower than that of 'natural persons'.[9]

It is also interesting that the discrepancy in total efficiency between natural persons and legal entities is the result of a lower scale efficiency of the latter. Although decreasing returns to scale do not necessarily imply allocative inefficiency, they may indicate that these farms operate beyond the profit-maximizing level that would be relevant for the case of perfect factor mobility. With Figure 1 in mind, this can be seen as a further sign that the LPG successors either consider a significant part of their capital costs to be sunk, or they emphasize the employment interests of their members. Both would imply diseconomies of scale. However, although nearly all legal entities show decreasing returns to scale, it should be mentioned that the largest efficient crop farm operates with 61 employees, with the number being 71 for the largest efficient livestock farm. These numbers are far beyond average employment levels for the legal entities group as a whole.

As already mentioned, DEA allows for the calculation of input and output 'slacks'. According to Table 4, labour slacks appear in 'legal entities' particularly if they specialized in animal farming, but not when they produce cash crops, while for natural persons labour slacks occur for crop farms only. In principle, the labour slacks of legal entities again support the thesis of a slower adjustment in LPG successors with livestock and pig production. They could stem from the existence of sunk costs or from a more general tendency for employment to be higher than necessary for profit maximization. The latter, however, should imply labour slacks for corporate cash crop farms, too, but this is not the case. Furthermore, the slacks for cooperatives and other corporate farms within the groups of cash crop farms and livestock farms turn out to be similar despite differences in the relation of members, employees and

TABLE 4 *Input slacks in relation to absolute input and efficiency (%)*

	n	Labour	Land	Variable inputs	Total efficiency	Technical efficiency
Cash crop farms						
Natural persons	29	4	3	1	87	91
Cooperatives	17	1	4	0	78	93
Other corporate farms	22	0	10	0	77	91
Livestock farms						
Natural persons	14	0	17	0	84	90
Cooperatives	90	4	7	0	65	83
Other corporate farms	38	3	12	0	76	86
All						
Natural persons	43	2	8	1	86	90
Cooperatives	107	3	6	0	67	85
with old debts	53	2	7	0	66	83
Other corporate farms	60	1	10	0	77	88
with old debts	18	1	4	0	72	89

shareholders. These two observations lead to the conclusion that the inefficiency of legal entities could be a result of sunk costs rather than of members' employment interests.

However, when we consider all farms, differences between cooperatives and limited liability companies become obvious. Cooperatives show lower technical efficiency, lower scale efficiency and higher labour slacks. Moreover, the analysis shows that, for 15 of the 210 farms having considerable labour slacks of more than five working units, 13 are cooperatives. This supports the thesis that the legal form has an impact on a farm's employment strategy.

The explanation of this discrepancy is probably rather simple. Most corporate cash crop farms of the sample are limited liability companies (65 per cent) while most animal farms are cooperatives (76 per cent). Obviously, production structure and legal form are not independent. Cash crop farms seem to prefer limited liability while livestock and mixed farms preferred to become cooperatives, with stronger incentives to concentrate on the much more labour-intensive and, in general, less profitable animal production. This is supported by Beckmann (1997) who finds that the decision in favour of a particular legal form mainly depends on the number of persons involved (the number of shareholders) and their interest in employment. Accordingly, the choice of a particular legal form has to be understood as a strategic decision. Former LPGs with high employment potential (that is, animal farms) tended towards the cooperative form in order to serve employment interests. A similar effect resulted probably from the existence of old debts. Although Table 4 shows a rather small efficiency impact of old debts, 50 per cent of the cooperatives

have old debts falling to 30 per cent for other legal entities. Obviously, the existence of debt had some effect on choice of legal form.

The slacks for labour in family farms and those for land in cash crop farms are difficult to interpret. The first may be a result of indivisibilities of labour units or simply overestimation of family labour input. The high land slack for livestock farms is likely to be caused by farms with suckler cow herds on marginal locations which receive considerable subsidies for 'extensification'. It is interesting that there are hardly any slacks for variable inputs. This provides evidence of rational behaviour independent of the legal form.

SUMMARY AND CONCLUSIONS

The empirical results suggest that the successors of the earlier East German production cooperatives (LPGs) made strenuous efforts to raise efficiency. On the one hand, this meant a marked reduction of the workforce, particularly affecting older and less-qualified workers (Czasch *et al.*, 1999). On the other hand, in doing so, they have probably helped to secure an important number of jobs because they adjusted slowly and still operate on a higher employment level. According to the results, during the first years after the beginning of transition, a strong positive employment effect emanated from sunk costs, resulting from a lack of alternatives for utilizing machinery and building capital that belonged to the legal successors of the non-liquidated LPGs. Moreover, the results suggest that there are positive employment effects resulting from the frequent identity of farm shareholders and farm workers. This identity has influenced the choice of legal form in order to serve the employment interests of the shareholders – particularly by choosing cooperative structures. Unfortunately, the results do not yet allow for a stricter measurement of the specific impacts of sunk costs, on the one side, and the legal form on the other. The reason is that these decisive variables are positively correlated. Further research will be necessary.

Although the 'legal entity' profits were still low in more recent periods, their technical productivity has sharply increased and has already surpassed the average West German family farm in several types of production (*Agrarbericht der Bundesregierung*, 1999; Balmann, 1999). In accordance with Mathijs and Swinnen (1997), the results indicate that the question of an optimal farm organization and farm size is much more complex than comparative–static transaction cost arguments suggest. This means that empirical results from comparative–static studies which ignore the historical background of transition should be interpreted cautiously. Ignoring sunk costs and the employment interests of the shareholders may be as misleading as ignoring them in the analysis of the family farming which dominates agriculture in most western countries. With regard to the future evolution of East German agriculture, two meaningful questions have to be answered. The first concerns the nature of organizational types (or type) which foster efficient management to serve the long-term interests of stakeholders. The second is the question of how a farm's organizational form might evolve if there were conflicting interests and asymmetric information among the shareholders.

NOTES

[1]Productivity is here understood as the residual factor income of labour, measured after all other variable factors are paid. If sunk costs for complementary factors exist, these are not relevant and therefore not considered. This implies that the marginal labour productivity reflects the shadow prices of labour input.

[2]For example, individual opportunity costs may deviate from wages if there is a danger of unemployment.

[3]Note that L^{max} is not necessarily larger than L' to L''. Rather, L^{max} has to be understood as an upper limit.

[4]Balmann *et al.* (1996) model a farm that can be seen as a representative legal entity with mixed production. The assumption of job maximization leads to the same number of employees as might be found for the average of the legal entities with mixed farming. Profit was in both cases slightly negative.

[5]There is an introduction to DEA in Charnes *et al.* (1994).

[6]Thiele and Brodersen (1999), for example, consider the balance, without the value of miscellaneous inputs and land, as a measure of capital input. However, this discriminates systematically against farms which operate with new buildings (for example, re-established dairy farms) and overestimates the efficiency of those with highly depreciated assets (LPG successors with buildings where there has been little effort to modernize equipment).

[7]Differences in standard deviations of the efficiency values are rather small and are not considered here.

[8]The replacement of the traditional 'Schwarzbuntes Milchrind' by Holstein-Friesian cows explains the enormous increases in milk yield, from a yearly average of 4439kg per cow in 1992/93 to 6107kg per cow in 1997/98 (*Agrarbericht der Bundesregierung*, various years).

[9]Considering the average corporate farm for Brandenburg leads to an increase in technical efficiency from 78 per cent in 1995/96 to 85 per cent in 1997/98, while the technical efficiency for an average family farm remains at the level of 66 per cent (that is far below our farm sample result for 'natural entities').

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