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RETURNS TO SCALE IN LITHUANIAN FAMILY FARMS: A QUALITATIVE APPROACH

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Abstract

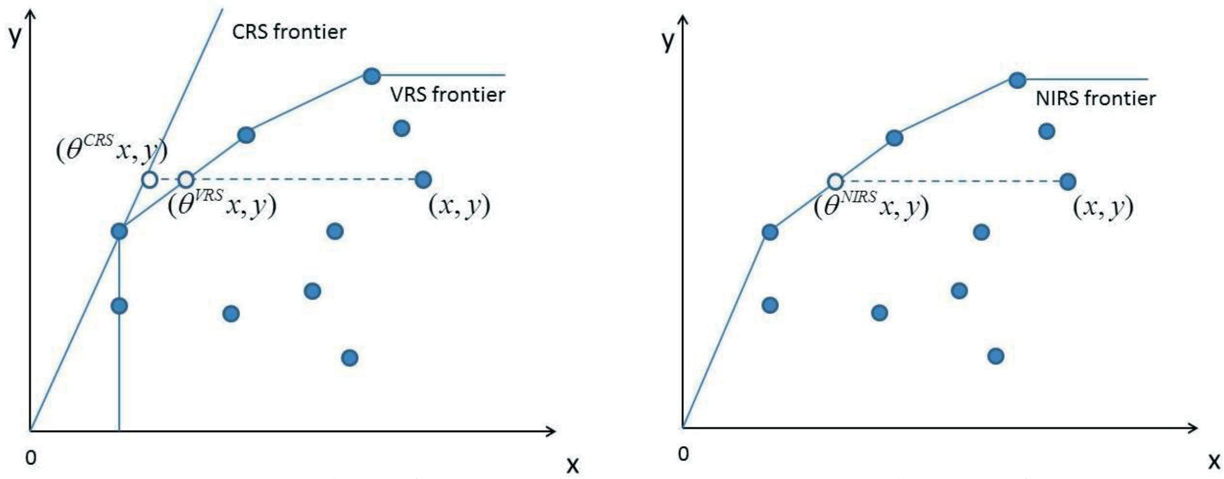
The optimal farm size and structure constitute an important issue for transitional economies. Indeed, modeling of the optimal farm size rests on an estimation of the returns to scale. This study estimated the optimal farm size in terms of different size measures. More specifically, the data envelopment analysis was employed to analyse the farm-level data and thus determine the prevailing returns to scale. This study utilised the qualitative approach (Färe et al., 1983; Färe, Grosskopf, 1985; Grosskopf, 1986). Furthermore, the economic indicators describing farm performance across different ranges of returns to scale were analysed. The Farm Accountancy Data Network data for 2004-2009 was used for the analysis. Results of the qualitative assessment of returns to scale across farming types did indicate that most of the analysed farms operated at a sub-optimal scale. The further analysis implied that farm size should be increased by the different means within different farming types. For instance, crop farms should reduce their labour input and UAA in order to ensure the scale efficiency. The economic size, however, needs to be expanded. Crop farms were operating at the optimal scale in terms of assets. Mixed farms should expand in terms of all of the size variables. Finally, livestock farms should increase their economic size and assets. Our study suggested that specialized crop farms should be ca. 280 ha in size, whereas mixed farms should cover 200 ha on average, and specialized livestock farms should reach 125 ha.

Keywords: most productive scale size, efficiency, data envelopment analysis, family farms.

Introduction

Agricultural sectors are relatively more important in the Central and East European countries than in the Western countries given the differences in the economic structure prevailing there. Therefore, research in agricultural efficiency is of particular importance in such countries (van Zyl et al., 1996; Gorton, Davidova, 2004; Kirner, Kratochvil, 2006). Indeed, farm size and farm structure do often constitute the key foci of economic research thanks to the land reform and farm restructuring there. The scale efficiency size is therefore a measure of interest as well as the most productive scale. The latter measures enable individuals to determine whether a farm operates at increasing, constant, or decreasing returns to scale. However, the issues of farm size were analysed across the whole world. Townsend et al. (1998), Luik et al. (2009), and Mugera and Langemeier (2011) applied data envelopment analysis to analyse the returns to scale and size of the agricultural producers. Alvarez and Arias (2004) employed the fixed-effects frontier and the translog supply function to relate the technical efficiency to the farm size.

The data envelopment analysis (DEA) enables the determination of whether a decision making unit (DMU) operates at the optimal scale size. This can be implemented by estimating the scale efficiency which, in turn, is a ratio between CRS efficiency scores and VRS efficiency scores. DMUs operating at the most productive scale size (MPSS) would be attributed with scale efficiency values of unity, whereas the remaining ones would feature scale efficiency scores lower than unity. However, this measure does not give any information regarding the direction of the prospective changes in scale size for the scale-inefficient DMUs. Accordingly, two approaches prevail allowing for a more detailed analysis of returns to scale (RTS) by the means of DEA (Førsund, Hjalmarsson, 2004; Zschille, 2012): The qualitative approach (Färe et al., 1983; Färe and Grosskopf, 1985; Grosskopf, 1986; Tone, 1996) enables us to determine whether a DMU operates under increasing returns to scale (IRS), CRS, or decreasing returns to scale (DRS). The quantitative approach further enables us to quantify scale elasticity in DEA. The latter analysis can be further employed in an indirect or a direct approach. The indirect approach was



a) CRS and VRS frontiers *b) NIRS frontier*

Fig. 1. Input-oriented DEA models based on different assumptions regarding returns to scale.

introduced by Banker and Thrall (1992) and utilized by Førsund and Hjalmarsson (2004), Førsund et al. (2007), Podinovski et al. (2009), and Zschille (2012). The direct approach was followed by Krivonozhko et al. (2004) and Førsund et al. (2007). In the sequel we will focus on the qualitative approach which classifies the farms in terms of the regions of RTS they operate in.

The Lithuanian agricultural sector, though, has not been sufficiently analysed in terms of optimal farm size and returns to scale. Kriščiukaitienė et al. (2007) employed the linear programming methodology to model the optimal farm size in terms of technological and economic variables. The latter study was based on a hypothetic farm data. Vinciūnienė and Rauluškevičienė (2009) employed DEA to estimate the efficiency and returns to scale in the Lithuanian family farms. That paper rested on the aggregate data from the Farm Accountancy Data Network (FADN). Jurkėnaitė (2012) analysed the viability of certain farming types in terms of various financial indicators.

The aim of this study was to estimate the optimal farm size in terms of different size measures. The following tasks were thus set: (i) to define the frontier methodology for estimation of RTS; (ii) to analyse the farm-level data and thus determine the prevailing RTS; (iii) to analyse the economic indicators describing farm performance across different ranges of RTS. This study utilised the qualitative approach (Färe et al., 1983; Färe and Grosskopf, 1985; Grosskopf, 1986) to estimate the prevailing RTS. The FADN data for 2004-2009 were used for the analysis.

The paper proceeds as follows: Section 2 presents the qualitative concept of RTS measurement by the means of DEA. Section 3 presents the data used for the analysis. Results of the empirical analysis are presented in Sections 4 and 5. Finally, conclusions are drawn in Section 6.

Preliminaries for the Qualitative Assessment of RTS

The qualitative approach of RTS analysis (Färe et al., 1983; Färe and Grosskopf, 1985; Grosskopf, 1986) is based on different assumptions on the underlying production frontier. Specifically, one has to assume CRS, VRS, and non-increasing returns to scale (NIRS) frontiers and estimate the associated efficiency scores, θ^{CRS}, θ^{VRS}, and θ^{NIRS} respectively. Fig. 1 depicts the said frontiers with observation (x, y) projected onto each of them. The CRS frontier is a line going from the point of origin through the most productive DMU, whereas the VRS frontier (curve) spans the linearly independent observations which are not dominated under the assumption of strong disposability. The NIRS frontier comprises the part of the CRS frontier below the maximal productivity range (MPSS) and the VRS frontier up to the first observation of the maximal productivity range.

Clearly, the DMUs operating at the MPSS will feature $\theta^{CRS} = \theta^{VRS}$, which implies CRS. The DMUs operating below the MPSS will feature $\theta^{CRS} \neq \theta^{VRS} > \theta^{NIRS}$, i.e., IRS. Finally, those DMUs operating above the MPSS will exhibit $\theta^{CRS} \neq \theta^{VRS} = \theta^{NIRS}$, which is merely DRS. Therefore, the point (x, y) falls within the range of DRS.

The required efficiency scores, θ^{CRS}, θ^{VRS}, and θ^{NIRS}, are obtained by solving certain linear programming problems. Let there be K DMUS identified by the index $k = 1, 2, \ldots, K$ using input quantities given by vectors $x_k = (x_{1,k}, x_{2,k}, \ldots, x_{m,k})$ and producing output quantities given by vectors $y_k = (y_{1,k}, y_{2,k}, \ldots, y_{n,k})$, where m and n are numbers of inputs and outputs respectively. The input-oriented CRS efficiency scores, θ_t^{CRS}, are then obtained by solving the following problem ($t = 1, 2, \ldots, K$):

$$\theta_t^{CRS} = \min\left\{\theta \left| \begin{array}{l} \sum_{k=1}^{K} \lambda_k x_{i,k} \le \theta x_{i,t}; i = 1,2,...,m; \\ \sum_{k=1}^{K} \lambda_k y_{j,k} \ge y_{j,t}; j = 1,2,...,n; \\ \lambda_k \ge 0, k = 1,2,...,K \end{array} \right. \right\}. \quad (1)$$

Eq. 1 is supplemented with the convexity constraint in order to obtain the VRS estimates:

$$\theta_t^{VRS} = \min\left\{\theta \left| \begin{array}{l} \sum_{k=1}^{K} \lambda_k x_{i,k} \le \theta x_{i,t}; i = 1,2,...,m; \\ \sum_{k=1}^{K} \lambda_k y_{j,k} \ge y_{j,t}; j = 1,2,...,n; \\ \sum_{k=1}^{K} \lambda_k = 1; \\ \lambda_k \ge 0, k = 1,2,...,K \end{array} \right. \right\}. \quad (2)$$

The NIRS are imposed by further modifying the convexity constraint, namely:

$$\theta_t^{NIRS} = \min\left\{\theta \left| \begin{array}{l} \sum_{k=1}^{K} \lambda_k x_{i,k} \le \theta x_{i,t}; i = 1,2,...,m; \\ \sum_{k=1}^{K} \lambda_k y_{j,k} \ge y_{j,t}; j = 1,2,...,n; \\ \sum_{k=1}^{K} \lambda_k \le 1; \\ \lambda_k \ge 0, k = 1,2,...,K \end{array} \right. \right\}. \quad (3)$$

It is obvious that the described qualitative assessment of RTS does not enable the quantification of the extent to which a certain DMU is above or below the MPSS. Nonetheless, this classification is quite useful for analysis of the environmental variables, for they can be analysed in accordance with the explicitly defined pattern of RTS.

Data Used

The data for 200 farms selected from the FADN sample covered the period of 2004–2009. Thus a balanced panel of 1200 observations was employed for analysis. Note that the whole annual FADN survey comprises some 1300 family farms. In addition, some farms are either included or excluded from the sample during the time. Therefore, the present dataset is the largest possible one given the current practice of FADN in Lithuania. The technical efficiency was assessed in terms of the input and output indicators commonly employed for agricultural productivity analyses. More specifically, the utilized agricultural area (UAA) in hectares was chosen as land input variable, annual work units (AWU) as labour input variable, intermediate consumption in Litas, and total assets in Litas as a capital factor. The last two variables were deflated by respective real price indices provided by Eurostat. On the other hand, the three output indicators represent crop, livestock, and other outputs in Litas (Lt), respectively. The aforementioned three output indicators were deflated by respective price indices. The analysed sample covers relatively large farms (mean UAA – 244 ha). As for labour force, the average was 3.6 AWU.

In order to quantify the differences in efficiency across certain farming types, the farms were classified into the three groups in terms of their specialization. Specifically, farms with crop output larger than 2/3 of the total output were considered as specialized crop farms, whereas those specific with livestock output larger than 2/3 of the total output were classified as specialized livestock farms. The remaining farms fell into a residual category called mixed farming.

Each farming type was analysed independently in order to avoid infeasibilities associated with extreme observations specific for different farming types. Furthermore, the super-efficiency DEA model (Andersen, Petersen, 1993) was employed to identify the outliers. The super-efficiency scores are obtained by virtue of the following model:

$$\theta_t^{S} = \min\left\{\theta \left| \begin{array}{l} \sum_{k=1}^{K} \lambda_k x_{i,k} \le \theta x_{i,t}; i = 1,2,...,m; \\ \sum_{k=1}^{K} \lambda_k y_{j,k} \ge y_{j,t}; j = 1,2,...,n; \\ \sum_{k=1}^{K} \lambda_k = 1; \\ \lambda_t = 0; \\ \lambda_k \ge 0, k = 1,2,...,K \end{array} \right. \right\}, \quad (4)$$

which implies that the DMU under assessment is excluded from the production frontier. Therefore, the input-oriented super-efficiency scores, θ_t^S, can get values from zero to infinity. In our case, those farms exhibiting super-efficiency scores above 1.2 were excluded from the sample. As a result the crop, mixed, and livestock farm samples comprised of 706, 148, and 121 observations respectively.

Returns to Scale across Farming Types

The prevailing returns to scale were analysed with each farming type. The qualitative method described in the preceding section was employed to classify the observations with respect to the RTS.

The crop farms were mainly operating under a sub-optimal scale. Indeed, some 71% of the observations associated with the latter farming type exhibited IRS, whereas 22% operated under DRS and the remaining 7% featured CRS (i.e., they operated in the range of the MPSS). Indeed, crop farms exhibited a decreasing share of farms operating at the sub-optimal scale (Fig. 2): The share of such farms dropped from 76% in 2004 to 68% in 2009. The share of farms operating at CRS increased from 7% up to 9% throughout the same period. The share of farms operating at the DRS (i.e., the supra-optimal scale) increased from 18% up to 23%. The aforementioned developments can be explained by crop farm expansion occurred during the research period.

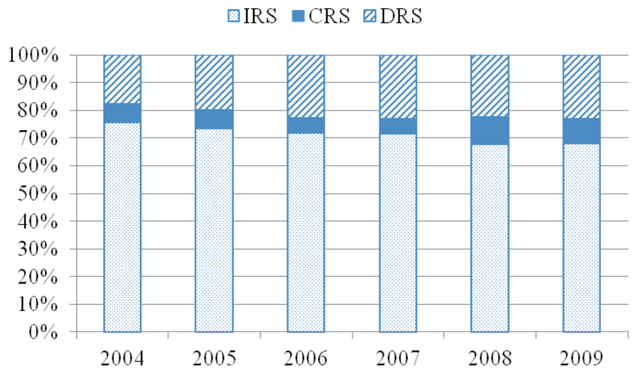


Fig. 2. The structure of crop farms in terms of RTS, 2004-2009.

The mixed farms also mainly operated in the range of the IRS (69% of the relevant observations). Some 16% of the observations exhibited CRS, yet another 15% featured DRS. Indeed, the structure of crop farms was a relatively stable one in terms of RTS. Fig. 3 presents the mixed farm structure in terms of the prevailing RTS.

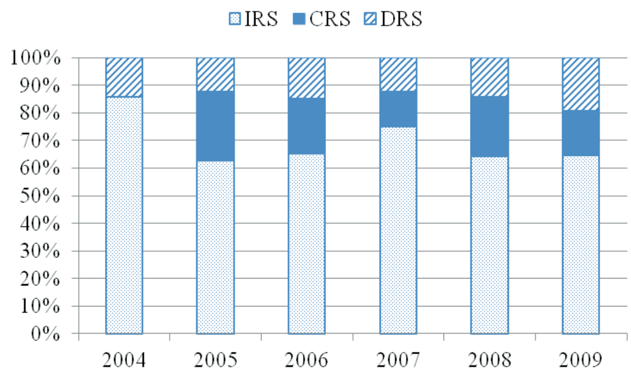


Fig. 3. The structure of mixed farms in terms of RTS, 2004-2009.

The livestock farming exhibited high variation in RTS. The share of observations associated with IRS decreased from 63% down to 59% (52% on average). However, the years 2004 and 2009 were specific with increases in shares of farms operating under the sub-optimal scale: Even 59-71% of the livestock farms operated under IRS during those periods. Some 26% of the livestock farms operated at the MPSS on average. The share of the livestock farms operating at the supra-optimal scale varied significantly across the years with the average value of 22%. Fig. 4 presents these developments.

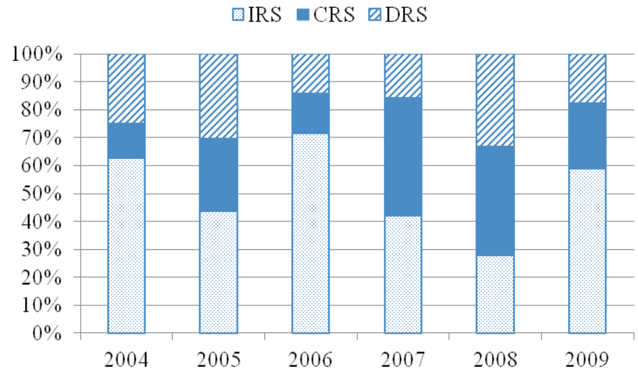


Fig. 4. The structure of livestock farms in terms of RTS, 2004-2009.

Results of the qualitative assessment of RTS across farming types did indicate that most of the analysed farms operated at a sub-optimal scale. The highest share of farms operating under IRS was observed for the crop and mixed farming (71% and 69% respectively). On the other hand, it was the livestock and mixed farms that exhibited the most frequent occurrences of DRS (22% and 15% respectively). The results revealed that the livestock farms can be considered as those operating at the optimal scale size to the highest extent (26% of observations) if compared to mixed (16%) or crop (7%) farms. However, the livestock farms did also exhibit the highest variation in the operation scale. Therefore, the agricultural policy should support consolidation of the crop farms to some extent. The livestock farms, though, might require some additional income smoothing measures.

Farm Performance under Different Ranges of RTS

This section analyses the differences in economic variables describing farm performance across different ranges of RTS. More specifically, the analysed variables can be grouped into those identifying farm size and those describing the underlying production processes. Farm size variables include farm size in economic size units (ESU), annual work units (AWU), utilised agricultural area (UAA), as well as certain monetary measures (intermediate consumption, total output, assets, production subsidies, and investment subsidies). Subsequently, the ratios between the said measures were treated as economic indicators describing the intensity of the production process. The share of crop output in the total output captured the degree of farm specialisation. Indeed, public support policy, price dynamics, technological innovations, etc., have different impacts on each of the analysed variables.

Table 1 presents the mean values of the analysed variables for the crop farms. Accordingly, the specialised crop farms achieve their optimal scale

Table 1

Crop farm performance variables under different RTS, 2004-2009 (N=706)

Variable	IRS	CRS	DRS	Sample Mean
Farm size and specialisation				
Farm size in ESU	49	70	121	66
Farm size in AWU	3.4	3.0	6.1	3.9
Farm size (UAA), ha	235	282	557	307
Total output, Lt	383,023	695,863	1,051,719	549,147
Intermediate consumption, Lt	257,814	366,734	655,235	351,092
Assets, Lt	769,777	1,023,978	1,845,506	1,019,381
Production subsidies, Lt	109,750	128,842	248,471	140,969
Investment subsidies, Lt	36,925	44,601	91,510	49,221
Crop output, % of the total output	0.96	0.88	0.97	0.96
Single factor intensity and productivity				
Intermediate consumption, Lt/ha	1098	1301	1177	1142
Assets, Lt/ha	3278	3633	3314	3315
Total output, Lt/ha	1631	2469	1889	1786
Support intensity				
Production subsidies, % of the total output	29	19	24	26
Production subsidies, Lt/ha	467	457	446	458
Investment subsidies, Lt/ha	157	158	164	160
Investment subsidies, % of assets	4.8	4.4	5.0	4.8

size at 70 ESU (i.e. at the gross profit margin of 84,000 EUR per annum), whereas the observed value was 66 ESU. Therefore, the crop farms should seek to increase their gross profit by some 3 ESU on average, which is obviously not a decisive improvement. The labour input should be decreased by some 0.9 AWU on average in order to approach the level observed at the range of CRS (viz. 3.0 AWU). Interestingly, the observed mean farm size in hectares (307 ha) exceeded the mean farm size in the range of CRS (282 ha) implying that land might not be used as productively as possible in the crop farming. Meanwhile, the mean total output was lower than that observed in the range of CRS, implying that the total output gains should reach some 145 thousand EUR on average in order to ensure the optimal scale size (note that these are deflated to 2005 EUR). The levels of intermediate consumption, assets, production subsidies, and investment subsidies did not differ to a high extent across the CRS observations and the sample means. The results showed that farms operating at the MPSS featured a certain degree of diversification: The latter farms exhibited a lower mean share of crop output in the total output (88%) than an average crop farm (96%). Indeed, such diversification might increase the total output generated in a farm and thus increase the technical and scale efficiency.

The crop farms operating at the MPSS exhibited higher factor intensities and productivity than those operating at a sub- or supra-optimal scale. It can therefore be concluded that farms operating at a supra-optimal scale did not manage to maintain a sufficient level of intermediate consumption and investments at the given farm size and thus yielded lower productivity. Farms operating at the optimal scale also were peculiar with the lowest support intensity[1] rates based on the total output or assets. However, that did not hold for the sums of subsidies per hectare.

The mixed farms operated below the CRS with respect to all of the considered farm size measures (cf. Table 2). The economics size of 42 ESU was that peculiar to the CRS observations, whereas the sample mean was 23 ESU. The labour input was not extremely different from the optimal one for an average farm, although mixed farms

[1] Throughout the study, the term intensity is used to refer to the rate of subsidies rather than the share of public support in the supported projects.

Table 2

Mixed farm performance variables under different RTS, 2004-2009 (N=148)

Variable	IRS	CRS	DRS	Sample mean
Farm size and specialisation				
Farm size in ESU	12	42	53	23
Farm size in AWU	2.4	3.7	6.6	3.2
Farm size (UAA), ha	68	203	318	127
Total output, Lt	107,338	455,330	599,883	236,985
Intermediate consumption, Lt	69,298	272,398	354,335	144,603
Assets, Lt	246,616	1,003,953	1,428,236	545,073
Production subsidies, Lt	35,897	101,139	156,058	64,339
Investment subsidies, Lt	5,635	39,075	17,167	12,772
Crop output, % of the total output	0.47	0.50	0.46	0.48
Single factor intensity and productivity				
Intermediate consumption, Lt/ha	1,021	1,344	1,113	1,139
Assets, Lt/ha	3,635	4,954	4,485	4,293
Total output, Lt/ha	1,582	2,247	1,884	1,867
Support intensity				
Production subsidies, % of the total output	33	22	26	27
Production subsidies, Lt/ha	529	499	490	507
Investment subsidies, Lt/ha	83	193	54	101
Investment subsidies, % of assets	2.3	3.9	1.2	2.3

should generally increase their labour force by about half of AWU. The mean farm size in hectares (127 ha) was also well below the optimum 203 ha. Both intermediate consumption and assets were lower at an average mixed farm if compared to an average farm operating in the range of CRS. The mixed farms operating at either a sub- or supra-optimal scale exhibited slightly lower degrees of specialization, i.e., they showed lower crop output shares if compared to farms operating in the range of CRS.

The mixed farms operating in the range of the MPSS exhibited the highest intermediate consumption and asset intensity per 1 ha. These farms were also specific with the highest land productivity. As for the support intensity, the optimal-sized mixed farms were peculiar with the lowest (or second lowest, depending on the indicator) rate of production subsidies and the highest rate of the investment subsidies. These findings can be explained by the fact that farms operating in the range of CRS are more likely to participate in investment subsidy programmes.

An average livestock farm should increase its economic size by a margin of just 3 ESU in order to operate in the range of CRS (Table 3). Most of the livestock farms used excessive labour force: The CRS farms featured mean labour input of 3.8 AWU, whereas the sample mean was 4.0 AWU. The farm size in hectares was already an optimal one for an average farm (125 ha). The total output of an average farm was lower if compared to the optimal-sized farms (401 thousand Lt and 514 thousand Lt, respectively). Therefore, livestock farms should increase their output along with intermediate consumption and assets rather than the land area. Although an average livestock farm received a lower amount of subsidies than the one operating in the range of CRS, an opposite trend was observed for the investment subsidies. Therefore, the livestock farms might not ensure the effective use of investments. More specialised livestock farms appeared to operate in the range of NIRS.

The livestock farms operating at the optimal scale exhibited the highest intermediate consumptions and asset intensity, which resulted in the highest land productivity. Indeed, the same pattern was observed for the labour productivity, which can be defined as a ratio of the total output over the amount of AWU: The sample mean was 101 thousand Lt/AWU, whereas CRS farms exhibited the value of 134 thousand Lt/AWU. The livestock farms operating in the range of CRS featured the lowest production support intensity if normalised by the total output and the highest one if normalised by the UAA. These farms, though, were peculiar with the lowest rates of investment subsidies.

Table 3

Livestock farm performance under different RTS, 2004-2009 (N=121)

Variable	IRS	CRS	DRS	Sample mean
Farm size and specialisation				
Farm size in ESU	14	25	39	22
Farm size in AWU	3.1	3.8	6.2	4.0
Farm size (UAA), ha	83	125	225	125
Total output, Lt	232,569	514,289	663,650	400,937
Intermediate consumption, Lt	121,887	229,798	351,285	200,722
Assets, Lt	641,566	1,053,045	1,481,105	934,321
Production subsidies, Lt	50,891	78,279	126,999	74,891
Investment subsidies, Lt	49,823	23,970	117,084	58,208
Crop output, % of the total output	0.22	0.22	0.25	0.23
Single factor intensity and productivity				
Intermediate consumption, Lt/ha	1,471	1,835	1,559	1,599
Assets, Lt/ha	7,744	8,409	6,574	7,445
Total output, Lt/ha	2,807	4,107	2,946	3,195
Support intensity				
Production subsidies, % of the total output	22	15	19	19
Production subsidies, Lt/ha	614	625	564	597
Investment subsidies, Lt/ha	601	191	520	464
Investment subsidies, % of assets	7.8	2.3	7.9	6.2

The discussed findings are summarized in Fig. 5. The charts presented there relate the observed sample means associated with respective farming types to the corresponding mean values in the region of CRS. The latter values, indeed, can be considered as some sort of optima.

Fig. 5 does clearly indicate that crop farms should reduce their labour input and UAA in order to ensure the scale efficiency. The economic size, however, needs to be expanded. The crop farms were operating at the optimal scale in terms of assets. The mixed farms should expand in terms of all of the size variables. Finally, the livestock farms should increase their economic size and assets.

The economic size of farms could be increased for all farming types (the ratios of the observed mean farm size in ESU to that in the region of CRS were 0.54–0.95). Labour input could be reduced for specialized farms (ratios of observed labour input to that associated with CRS were 1.31 and 1.04 for crop and livestock farms respectively), whereas mixed farms featured lower-than-optimal labour input (0.87). As for the land input, crop and livestock farms were specific with the observed levels close to those in the region of CRS (1.09 and 1 respectively). The mixed farms, though, could increase their land input (0.63). Finally, crop farms featured the optimal amount of assets, whereas mixed and livestock farms possessed too little fixed assets if compared to the region of CRS (0.54 and 0.88 respectively).

In order to check the consistency and robustness of the results, it is worthwhile to compare them with those obtained in previous research. Kriščiukaitienė et al. (2007) estimated that the optimal size of the cereal and rape farms is 200-470 ha, that of the mixed farms – 90-120 ha, and that of livestock farms (dairy farms) – 40-130 ha. Our study suggested that the specialized crop farms should be ca. 282 ha in size, whereas mixed farms should cover 203 ha on average, and the specialized livestock farms should reach 125 ha. As one can note, this study rendered higher optimal size estimates for the mixed farms possibly due to the underlying farm sample and different methodology.

Conclusions

Results of the qualitative assessment of returns to scale across farming types indicated that most of the analysed farms operated at a sub-optimal scale. The highest share of farms operating under IRS was observed for the crop and mixed farming (71% and 69% respectively). On the other hand, it was

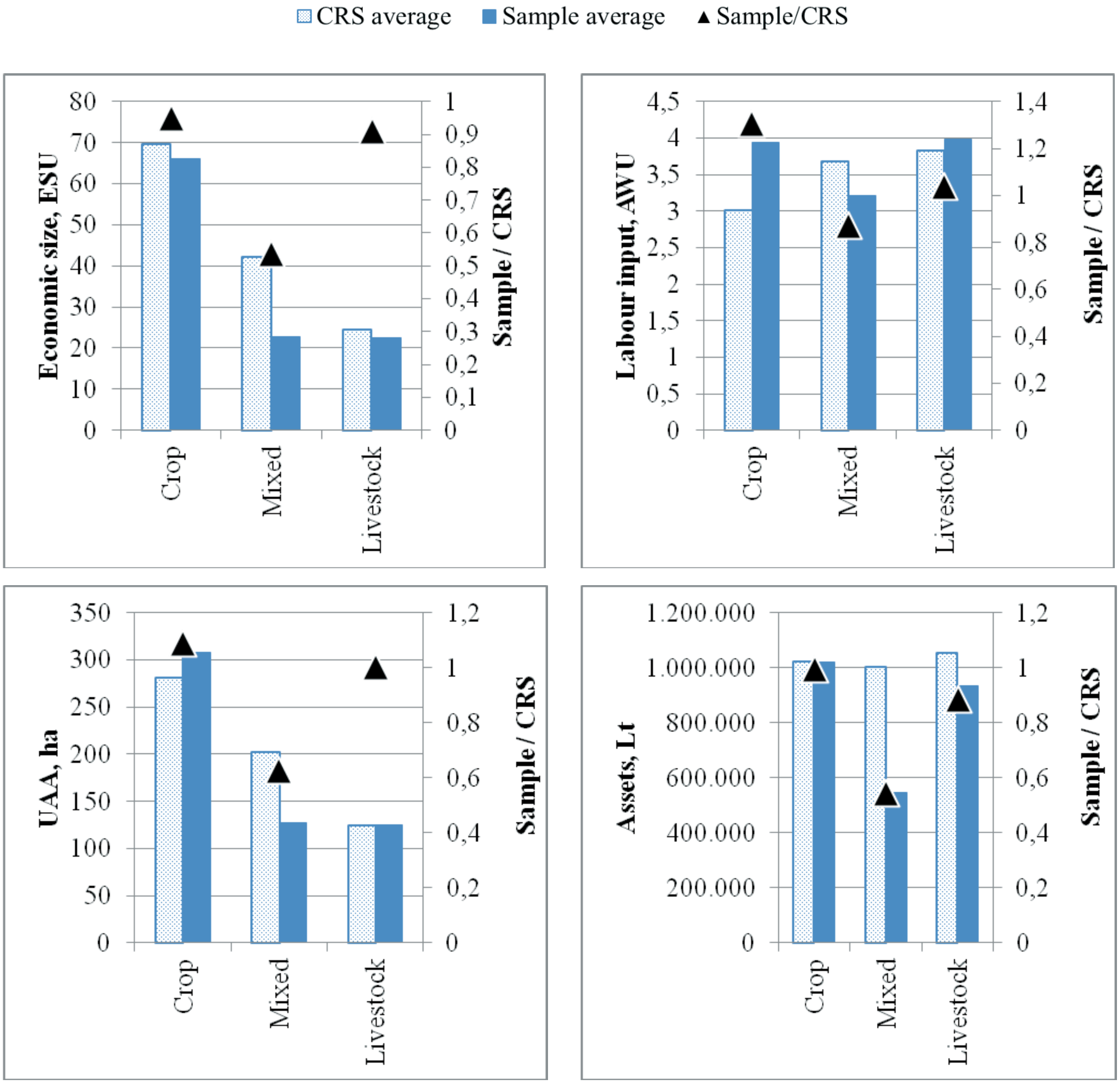


Fig. 5. Average values of farm size variables for the whole sample and in the range of CRS.

the livestock and mixed farms that exhibited the most frequent occurrences of DRS (22% and 15% respectively). The results revealed that the livestock farms can be considered as those operating at the optimal scale size to the highest extent (26% of observations) if compared to mixed (16%) or crop (7%) farms. However, the livestock farms also exhibited the highest variation in the operation scale. Therefore, the agricultural policy should support consolidation of the crop farms to some extent. The livestock farms, though, might require some additional income smoothing and quality improvement measures.

The further analysis implied that farm size should be increased by the different means within different farming types. For instance, crop farms should reduce their labour input and UAA in order to ensure the scale efficiency. The economic size, however, needs to be expanded. The crop farms were operating at the optimal scale in terms of assets. Mixed farms should expand in terms of all of the size variables. Finally, livestock farms should increase their economic size and assets. Our study suggested that specialized crop farms should be ca. 280 ha in size, whereas mixed farms should cover 200 ha on average, and specialized livestock farms should reach 125 ha.

The results also indicated that production subsidies might be related to farm structure in a rather negative way. Specifically, all the farming types exhibited the lowest production support rates in the ranges of the constant returns to scale if compared to means at the remaining ranges. Therefore, the production subsidies are likely to have a negative effect on farm scale efficiency.

Acknowledgements

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References

1. Alvarez, A., Arias, C. (2004). Technical efficiency and farm size: a conditional analysis. *Agricultural Economics*, 30, 241–250.
2. Andersen, P., Petersen, N. C. (1993). A procedure for ranking efficient units in data envelopment analysis. *Management Science*, 39, 1261–1264.
3. Banker, R. D., Thrall, R. M. (1992). Estimation of returns to scale using data envelopment analysis. *European Journal of Operational Research*, 62, 74–84.
4. Färe, R., Grosskopf, S. (1985). A nonparametric cost approach to scale efficiency. *The Scandinavian Journal of Economics*, 87 (4), 594–604.
5. Färe, R., Grosskopf, S., Lovell, C. A. K. (1983). The structure of technical efficiency. *The Scandinavian Journal of Economics,* 85 (2), 181–190.
6. Førsund, F. R., Hjalmarsson, L. (2004). Calculating scale elasticity in DEA models. *The Journal of the Operational Research Society*, 55 (10), 1023–1038.
7. Førsund, F. R., Hjalmarsson, L., Krivonozhko, V. E., Utkin, O. B. (2007). Calculation of scale elasticities in DEA models: Direct and indirect approaches. *Journal of Productivity Analysis*, 28, 45–56.
8. Gorton, M., Davidova, S. (2004). Farm productivity and efficiency in the CEE applicant countries: a synthesis of results. *Agricultural Economics*, 30, 1–16.
9. Grosskopf, S. (1986). The role of the reference technology in measuring productive efficiency. *The Economic Journal*, 96, 499–513.
10. Jurkėnaitė, N. (2012). Lietuvos ūkininkų ūkių ekonominio gyvybingumo palyginamoji analizė. *Žemės ūkio mokslai*, 19 (4), 288–298.
11. Kirner, L., Kratochvil, R. (2006). The Role of Farm Size in the Sustainability of Dairy Farming in Austria: An Empirical Approach Based on Farm Accounting Data. *Journal of Sustainable Agriculture*, 28 (4), 105–124.
12. Kriščiukaitienė, I., Tamošaitienė, A., Andrikienė, S. (2007). Racionalaus dydžio ūkių modeliavimas. *Žemės ūkio mokslai*, 14 (priedas), 78–85.
13. Krivonozhko, V. E., Utkin, O. B., Volodin, A. V., Sablin, I. A., Patrin, M. (2004). Constructions of economic functions and calculations of marginal rates in DEA using parametric optimization methods. *Journal of the Operational Research Society*, 55, 1049–1058.
14. Luik, H., Seilenthal, J., Värnik, R. (2009). Measuring the input-orientated technical efficiency of Estonian grain farms in 2005–2007. *Food Economics - Acta Agriculturae Scandinavica, Section C*, 6 (3–4), 204–210.
15. Mugera, A. W., Langemeier, M. R. (2011). Does Farm Size and Specialization Matter for Productive Efficiency? Results from Kansas. *Journal of Agricultural and Applied Economics*, 43 (4), 515–528.
16. Podinovski, V. V., Førsund, F. R., Krivonozhko, V. E. (2009). A simple derivation of scale elasticity in data envelopment analysis. *European Journal of Operational Research,* 197, 149–153.
17. Tone, K. (1996). A Simple Characterization of Returns to Scale in DEA. *Journal of Operations Research Society of Japan*, 39 (4), 604–613.
18. Townsend, R. F., Kirsten, J., Vink, N. (1998). Farm size, productivity and returns to scale in agriculture revisited: a case study of wine producers in South Africa. *Agricultural Economics*, 19, 175–180.
19. van Zyl, J., Miller, W., Parker, A. (1996). *Agrarian structure in Poland: the myth of large farm superiority*. Policy Research Working Paper No 1596. The World Bank, Washington, DC
20. Vinciūnienė, V., Rauluškevičienė, J. (2009). Lietuvos respondentinių ūkininkų ūkių techninio ir masto efektyvumo neparametrinis vertinimas. *LŽŪU mokslo darbai*, 85 (38), 39–46.
21. Zschille, M. (2012). *Nonparametric Measures of Returns to Scale: An Application to German Water Supply*. GRASP Working Paper 31.

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Masto grąža Lietuvos ūkininkų ūkiuose: kokybinis požiūris

Santrauka

Centrinės ir Rytų Europos valstybėse žemės ūkio sektorius yra santykinai svarbesnis nei Vakarų Europos valstybėse dėl ekonominės struktūros skirtumų. Taigi žemės ūkio sektoriaus efektyvumas yra ypač svarbus mokslinių tyrimų klausimas Lietuvoje. Siekiant padidinti žemės ūkio politikos veiksmingumą, svarbu nustatyti optimalų (racionalų) ūkininkų ūkių veiklos mastą. Optimalus ūkio dydis ir ūkių struktūra yra vienos iš aktualiausių pereinamosios ekonomikos problemų, nes pastarosiose ekonominėse sistemose ūkių struktūros pokyčių procesai vyko (ir vyksta) itin sparčiai. Lietuvoje optimalus ūkininkų ūkių dydis nagrinėtas atskirais aspektais. Kriščiukaitienė ir kt. (2007) pritaikė tiesinio programavimo metodiką modeliuodami ūkio dydį pagal technologinius apribojimus (empiriniai ūkių duomenys tiesiogiai nebuvo naudojami). Vinciūnienė ir Raulučkevičienė (2009) analizavo masto efektyvumo sklaidą pagal suvestinių ūkininkų ūkių duomenis. Pažymėtina, kad masto efektyvumas neleidžia įvertinti, ar mastas yra per didelis, ar per mažas.

Optimalaus ūkio dydžio modeliavimas grindžiamas masto grąžos analize. Masto grąžos analizė gali būti atliekama dviem būdais: 1) kokybiniu ir 2) kiekybiniu. Atliekant kokybinę masto grąžos analizę, vertinama tik masto grąža (didėjanti, pastovi, mažėjanti), tačiau masto elastingumas neskaičiuojamas. Kiekybinis vertinimas suteikia galimybę nustatyti ir masto elastingumą, tačiau efektyviems ūkiams reikia numatyti papildomus įvertinius. Kokybinis vertinimas atliktas taikant duomenų apgaubties analizės metodus (Färe ir kt., 1983; Färe, Grosskopf, 1985; Grosskopf, 1986). Šie metodai leidžia įvertinti ūkių veiklos efektyvumą atsižvelgiant į skirtingas prielaidas apie gamybinės technologijos masto grąžą (kintanti, pastovi, mažėjanti). Įvertinus ūkių efektyvumą atsižvelgiant į skirtingas prielaidas, juos galima klasifikuoti pagal masto grąžos sritį, kurioje veikia atitinkamas ūkis.

Šiame tyrime naudoti ūkių apskaitos duomenų tinklo duomenys. Tyrimo imtis apėmė 200 respondentinių Lietuvos ūkininkų ūkių, veikusių 2004–2009 m., taigi naudoti 1200 stebėjimų duomenys. Straipsnyje modeliuojamas optimalus ūkininkų ūkių dydis, išreikštas skirtingais matais. Papildomai buvo analizuojami ekonominiai ūkių veiklos rodikliai skirtinguose masto grąžos intervaluose. Tyrimo rezultatai parodė, kad dauguma ūkių veikė mažesniu nei optimalus mastu, t. y. didėjančios masto grąžos intervale. Tolesnė analizė atskleidė, kad ūkių dydis turėtų būti didinamas skirtingomis kryptimis atsižvelgiant į ūkininkavimo tipą. Augalininkystės ūkiai turėtų sumažinti darbo sąnaudas ir žemės ūkio naudmenų plotą, tačiau didinti ekonominį savo dydį. Augalininkystės ūkiuose naudojamo ilgalaikio turto dydis buvo artimas optimaliam. Mišrūs ūkiai turėtų plėstis visais atžvilgiais. Gyvulininkystės ūkiai turėtų didinti ekonominį dydį ir ilgalaikio turto apimtį. Atliktas tyrimas leidžia teigti, jog optimalus augalininkystės ūkio dydis yra apie 280 ha, mišraus ūkio – 200 ha, gyvulininkystės – 125 ha. Ekonominis ūkių dydis turėtų būti didinamas visų tipų ūkininkystėje (santykis tarp faktinio vidurkio ir reikšmės pastovios masto grąžos srityje buvo 0,54–0,95). Darbo sąnaudos turėtų būti mažinamos specializuotuose ūkiuose (augalininkystės ir gyvulininkystės ūkių atitinkamų santykinių rodiklių reikšmės buvo atitinkamai 1,31 ir 1,04), o mišriuose ūkiuose jos buvo mažesnės nei esant optimaliam mastui (0,87). Dirbamosios žemės plotas augalininkystės (1,09) ir gyvulininkystės (1) ūkiuose buvo beveik optimalus, o mišrūs ūkiai jos naudojo per mažai (0,63). Augalininkystės ūkiuose buvo naudojamas optimalus ilgalaikio turto kiekis, o mišrūs ir gyvulininkystės ūkiai naudojo per mažus kiekius (atitinkamai 0,54 ir 0,88).

Pagrindiniai žodžiai: produktyviausias gamybos mastas, efektyvumas, duomenų apgaubties analizė, ūkininkų ūkiai.

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