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Profitability and efficiency of Czech dairy farms in LFAs

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Abstract

The Czech dairy sector experienced dramatic changes after the accession of the Czech Republic to the European Union. The development after the year 2004 can be characterized by a reduction in the number of cows, growth in the milk yield, capital market imperfections, strong dependency of the local farm price on the world market price development and strong dependency of farm performance on policy measurement, namely quotas and subsidies. The aim of the paper is to evaluate the profitability and efficiency of Czech dairy farms from the point of view of less favoured areas (LFAs) and with respect to the policy measurement changes. The evaluation will be addressed using two main methods, namely stochastic frontier estimation and Spearman correlation coefficient computation. The calculations and estimations are based on unbalanced panel data of Czech dairy farms–local entities drawn from the Registr32 database and the State Agricultural Intervention Fund database. The data set covers the period from 2004 to 2013.

Keywords

Dairy, efficiency, LFA, policy, profitability, subsidies.

JEL Classification: Q12, Q18

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1. Introduction

The Czech Republic entered the European Union (EU) in 2004, opening the free market to new opportunities and challenges. It also meant the introduction of the Common Agricultural Policy (CAP) and its market regulations and interventions as well as new subsidies for farms in less favoured areas (LFAs). Farms managed within LFAs are disadvantaged in relation to those outside LFAs – by altitude, slopes or specific limitations. The classification for LFAs changed together with the CAP policy period.

The first payments for less favoured areas in the EU were distributed in 1972, but many farms in less favoured areas did not meet the requirements to obtain the LFA payments. Firstly there were three areas – mountainous (handicaps – slope, altitude), areas facing the threat of depopulation (with a high number of people working in agriculture, etc.) and areas with specific handicaps (small islands, high salinity levels, etc.) (Institute for European Environmental Policy for DG Agriculture, 2006).

In 1985 it was established that LFA subsidies are paid per livestock unit (LSU) or hectare of defined agricultural land. Then in 1999 minimal and maximal payments were set – a minimum of ECU 20.3 (the European currency unit) per LSU or hectare and a maximum of ECU 150/LSU or 1 hectare. For the years 2000–2006, a minimum payment of EUR 25/LSU or hectare and a maximum payment of EUR 200/CSU or hectare were set. For the period 2006–2013, the payments were divided into mountainous and non-mountainous areas – the mountainous maximum payment was EUR 250 and non-mountainous maximum payment was EUR 150 (Institute for European Environmental Policy for DG Agriculture, 2006).

Supporting payments are also financed by the Czech state budget and are defined in the Law of Agriculture from 1997. In 2001 payments were set for mountainous areas from EUR 63 to 106 per hectare, for other areas from EUR 24 to 91 and for areas with a specific handicap from EUR 19 to 37. In 2002 all the payments were increased by EUR 4 or 8.

Since entering the European Union, the LFA subsidies are paid by the EU and evened up by the Czech state budget (but they are paid only due to hectares – mountainous areas around 146 EUR/he, other areas around EUR 109/he and areas with specific handicaps a maximum of EUR 125/he).

LFA payments are designed and connected with the Leader and Pillar One of the EU to maintain farm production in those areas that are handicapped, which should prevent the process of rural depopulation and take actions against the abandonment of agricultural land or its conversion to alternative land uses (Štolbová, 2007).

Nowadays (since 2000) less favoured areas in the Czech Republic are divided into three main areas – mountainous, other and those with specific handicaps. Mountainous areas can be separated into five subdivisions and other areas into two subdivisions.

The paper focuses on the dairy sector, the current position of which can be described in terms of basic production and trade characteristics based on the Ministry of Agriculture ČR data. The milk production fluctuates around 2,700 million litres (the average in 2004–2015 was 2,726 m l), with the average yields to the value 6,917 kg per cow and 395,914 milk cows on average. Most of the milk volume produced in the Czech Republic is marketed through milk producers' organizations (MPOs). Bošková (2014) quantified the share of MPOs in the raw milk sales on the level of 70%. The production is realized on the market with an average price of CZK 7.81/l (EUR 0.29/l).

Dairy farmers in LFAs can obtain extra subsidies for dairy production if they farm cows on grasslands – the minimum intensity is set by the livestock unit as well as being determined by the minimum size of farmed land for each less favoured area, the largest of which is in mountainous areas, then specific areas and lastly other areas. The exact size of the farm and the amount of livestock units changes (for example for 2015 the payments in mountainous areas were EUR 83–137/he, other areas EUR 57–82/he and areas with specific handicaps EUR 83/he). Those payments are important income as well.

Besides those mentioned above, dairy farmers in LFAs (as well as those outside less favoured areas) can apply for other subsidies connected with dairy production: for ruminants, for cattle with market milk production and for payments for animal welfare (the total of the payments is set by the livestock units) (eAgri, 2015).

The aim of the paper is to evaluate the profitability and efficiency of Czech dairy farms in the context of less favoured areas and with respect to the policy measurement changes. The paper addresses the following research questions: How did policy measurements contribute to the profitability and efficiency of dairy farms farming in LFAs? Are there any differences in the profitability and efficiency of dairy farms and their development within LFAs and outside LFAs?

The achievement of the research objectives extends the knowledge of the Czech dairy sector economy and the competitiveness of dairy farms. The performance of Czech dairy farms has only been analysed in a few studies (e.g. Bošková, 2014; Špička, 2013), and these studies have typically measured the performance physically by total factor productivity and technical efficiency. It was also analysed in our study about performance from the regional point of view – Maxová and Žáková Kroupová (2015). Kumbhakar and Lien (2009) pointed out that the maximization of productivity growth might not correspond to the profit maximization that is the goal of most producers. They suggested measuring performance in terms of profit and decomposed profitability into components such as output growth, output and input price changes, technical change, returns to scale, mark-up and technical efficiency change.

The rest of the paper is organized as follows. We introduce the data and the methods used, and then we present the results of our analysis. Firstly, the IDF estimates are commented on and the technical efficiency of dairy farmers is discussed. Secondly, we analyse the profit of farms in different LFAs with respect to LFA subsidies. Then, we analyse profitability and its components due to less favoured areas. Finally, the impact of the agricultural policy on the profitability change is discussed and a conclusion is provided.

2. Methods and materials

The analysis uses two main methods, namely stochastic frontier estimation and Spearman correlation coefficient computation which are set in a Research model. The calculations and estimations are based on unbalanced panel data of Czech dairy farms–local entities drawn from the Registr32 database, the State Agricultural Intervention Fund database and Czech Statistical Office database. The data set covers the period from 2004 to 2013.

2.1 Research model

The analysis of the performance of Czech dairy farms is based on Sipiläinen et al.'s (2013) extension of Kumbhakar and Lien's (2009) approach to profitability decomposition; see equation (1).

$$\frac{1}{C}\frac{d\pi}{dt} = \dot{Y}_P\left(\frac{R}{C} - 1\right) + \dot{P}\frac{R}{C} - \dot{W} + TC + \left[(1 - RTS^{-1})\dot{Y}_C\right] + \left(\dot{Y}_P - \dot{Y}_C\right) + \dot{TE}, \tag{1}$$

where π is the profit, **R** is the total revenue, **C** is the total cost, $\dot{Y}_P$ is the rate of change in output weighted by the output revenue shares, $\dot{Y}_C$ is the rate of change in output weighted by the estimated output cost elasticities, $\dot{P}$ is the rate of change in the output price, $\dot{W}$ is the input price change, **TC** is the technical change, **RTS** is the returns to scale, $\dot{TE}$ is the technical efficiency change and **t** is time.

From equation 1 it is evident that the profitability change can be decomposed into seven components: (i) the output growth component $\dot{Y}_P(R/C - 1)$, (ii) the output price change component $\dot{P}(R/C)$, (iii) the input price change component $\dot{W}$, (iv) the technical change component **TC**, (v) the scale component $(1 - RTS^{-1})\dot{Y}_C$, (vi) the mark-up component $\dot{Y}_P - \dot{Y}_C$ and (vii) the technical efficiency change $\dot{TE}$.

Components (i)–(iii) can be computed directly from the observed data according to the following equations based on Sipiläinen et al. (2013) modified for one output of production:

$$\dot{Y}_P\left(\frac{R}{C} - 1\right) = \frac{(Y_{m,t} - Y_{m,t-1})}{\frac{1}{2}(Y_{m.t} + Y_{m,t-1})}\left(\frac{R}{C} - 1\right), \tag{2}$$

where
$$\frac{R}{C} = \frac{\frac{1}{2}(TS_{m,t} + TS_{m,t-1}) + \frac{1}{2}(\ddot{Y}_{m,t} + \ddot{Y}_{m,t-1})}{\sum_j \frac{1}{2}(W_{j,t} + W_{j,t-1})\frac{1}{2}(X_{j,t} + X_{j,t-1})}, \tag{3}$$

$$\dot{P}\frac{R}{C} = \frac{(P_{m,t} - P_{m,t-1})}{\frac{1}{2}(P_{m,t} + P_{m,t-1})}\frac{R}{C}, \tag{4}$$

$$\dot{W} = \sum_j \frac{\frac{1}{2}(W_{j,t} + W_{j,t-1})\frac{1}{2}(X_{j,t} + X_{j,t-1})}{\sum_j \frac{1}{2}(W_{j,t} + W_{j,t-1})\frac{1}{2}(X_{j,t} + X_{j,t-1})}\frac{(W_{j,t} - W_{j,t-1})}{\frac{1}{2}(W_{j,t} + W_{j,t-1})}, \tag{5}$$

where P_m is the price of output m, Y_m is the quantity of output m, $\ddot{Y}_m$ is the monetary value of output m, W_j is the price of input *j* (*j* = 1, …, *J*) and X_j is the quantity of input *j* (*j* = 1, …, *J*).

As Sipiläinen et al. (2013) noted, employing averages of the consecutive periods *t*–1 and *t* ensures that the analysis is time consistent for *static* variables.

The computation of the rest of the components, (iv)–(vii), is based on the estimation of the cost function. The cost function estimation needs information about the input prices. However, since this information is limited and the variability of the input price is low for such estimation, we employ the duality theorem and estimate an input distance function (IDF). Using the homogeneity property, we can estimate the following stochastic translog IDF with M outputs and J inputs based on panel data:

$$-\ln X_{1i,t} = (\alpha_0) + \sum_{m=1}^{M} \beta_m \ln Y_{mi,t} + \frac{1}{2}\sum_{m=1}^{M}\sum_{n=1}^{N} \beta_{mn} \ln Y_{mi,t} \ln Y_{ni,t} + \sum_{j=2}^{J}\sum_{k=2}^{K} \beta_{jk} \ln \widetilde{X}_{ji,t} \ln \widetilde{X}_{ki,t} + \alpha_t t + \frac{1}{2}\alpha_{tt} t^2 + \sum_{m=1}^{M} \alpha_{mt} \ln Y_{mi,t}\, t + \sum_{j=2}^{J} \beta_{jt} \ln \widetilde{X}_{ji,t}\, t + v_{i,t} - u_{i,t}. \quad (6)$$

where $\ln \widetilde{X}_{jit} = \ln X_{jit} - \ln X_{1i,t}$ and α, β, δ are parameters to be estimated. The symmetry restrictions imply that $\beta_{jk} = \beta_{kj}$ and $\beta_{mn} = \beta_{nm}$. $v_{i,t} \sim iidN(0, \sigma_v^2)$ is a stochastic error term and $u_{i,t} \sim N^{+}(\mu, \sigma_{ui,t}^2)$ is a time-varying inefficiency.

We also normalize all the variables in logarithms by their sample mean, which makes it possible to interpret the estimated first-order parameters as elasticities at the sample mean. Equation 6 is estimated in the form of a true fixed-effect model (TFEM) to the farm heterogeneity captured using the maximum simulated likelihood method in the econometric software LIMDEP 9.0.

Following Kumbhakar and Lien (2009), the TC component that takes into the account the averages of the consecutive periods *t*–1 and *t* can be computed from the IDF as shown in equation (7):

$$TC = -\frac{\partial \ln X_1}{\partial t} = \alpha_t + \alpha_{tt} t + \sum_{m=1}^{M} \alpha_{mt} \ln Y_{mi,t} + \sum_{j=2}^{J} \beta_{jt} \ln \widetilde{X}_{ji,t}. \quad (7)$$

The scale component is computed using the following equations (8)–(10):

$$RTS = \frac{1}{\sum_m \partial \ln X_1 / \partial \ln Y_m} \quad (8)$$

$$\frac{\partial \ln X_1}{\partial \ln Y_{mi,t}} = -\Big(\beta_m + \sum_{n=1}^{N} \beta_{mn} \ln Y_{ni,t} + \delta_{mj} \sum_{j=2}^{J} \ln \widetilde{X}_{ji,t} + \alpha_{mt} t\Big) \quad (9)$$

$$\dot{Y}_C = RTS \sum_m \frac{\partial \ln X_1}{\partial \ln Y_{mi,t}} \frac{(Y_{m,t} - Y_{m,t-1})}{\frac{1}{2}(Y_{m,t} + Y_{m,t-1})} \quad (10)$$

Equation 10 is also used to compute the mark-up component. Finally, the technical efficiency change is computed using equation (11):

$$\dot{TE}_{i,t} = \frac{TE_{i,t} - TE_{i,t-1}}{\frac{1}{2}(TE_{i,t} + TE_{i,t-1})}, \quad (11)$$

where the technical efficiency is estimated using the Jondrow et al. (1982) approach.

2.2 Sample and data collection

The analysis uses unbalanced panel data of Czech dairy farms–local entities drawn from the Registr32 database and the State Agricultural Intervention Fund database. The data set covers the period from 2004 to 2013 and consists of 470 cases that were gained from 47 farms specialized in dairy production. The farms are divided into 8 areas – 7 types of LFA areas and a non-LFA area – based on the Ministry of Agriculture methodology. We use the following outputs and inputs in this study to estimate the IFD: total output (y_1), support payments (y_2), labour measured in AWU (x_1), total utilized land in hectares (x_2), capital (x_3) and material and energy (x_4). The inclusion of support payments is based on the Kumbhakar and Lien (2009) approach, which deals with the goal to include all farms' incomes in the profitability function. The output price for milk and input prices for labour and land are taken from the Czech Statistical Office database.

2.3 Data analysis and discussion

The basic characteristics of the observed sample are presented in Table 1. The outputs as well as the inputs (except labour and land) are deflated by price indices (aggregated agricultural output and input indices (2010 = 100) – source: the Czech Statistical Office database).

Table 1 Characteristics of the sample in LFA and outside LFA areas (EUR 1 = CZK 27.425)[1]

	LFA mean	*LFA st. dev.*	*nLFA mean*	*nLFA st.dev.*
O	6,867.6	10,314.4	6,676.5	10,569.4
L	648.6	743.1	657.0	789.7
W	97	195	109	209
M	5,769.0	7,193.1	5,619.7	7,320.4
C	132,231.2	190,267.3	129,707.6	196,551.3
TS	226,972.4	290,608.2	222,015.2	304,020.0
LS	48,128.2	67,994.2	none	none

We divide the farms into 8 areas – 7 types of LFA areas and the rest. The farms are sorted by the official LFA areas in the Czech Republic; the areas are divided by districts and by metres above sea level. We pinpoint each farm of the sample and assign it to a district and less favoured area.

- H1 800 m.a.s.l. and more
- H2 700 m.a.s.l.–less than 800 m.a.s.l.
- H3 600 m.a.s.l.–less than 700 m.a.s.l.
- H4 less than 600 m.a.s.l., a slope above 15% in more than 50% of the area
- H5 less than 600 m.a.s.l., a slope above 15% in less than 50% of the area
- OA other areas in the LFA (population density is lower than 75 citizens/km^2, employment in agriculture is more than 8%)

[1] **O** – Output (EUR), **L** – Land (hectares), **W** – Work (persons), **M** – Materials and Energy (EUR), **C** – Capital (EUR), **TS** – Total subsidies (EUR), **LS** – LFA subsidies (EUR)

OB added areas to the OA in the homogenization process (none of the observed farms is in this area)
S specific areas with small productivity of farmland and a high slope
N areas outside LFAs

In the Czech Republic, 50.8% of agricultural land is defined as a less favoured area – mountainous areas (H1–H5) account for 15% of agricultural land and other LFAs (OA, OB) for 28.8% and areas affected by specific handicaps account for 6.6% of agricultural land. The rate is changing due to the Common Agricultural Policy – the less favoured areas are defined regularly in the rural development programme.

If we compare the average characteristics of farms in LFAs and outside LFAs, we can see that there are no big differences in their basic features. Farms have a similar size (by worker count and by land size). The average Czech dairy farm has around 650 hectares of land (farms are quite large compared with the rest of the EU), employs 100 employees and obtains EUR 226,972 in subsidies from the EU and the Czech Republic.

However, the standard deviation in LFA and non-LFA areas suggests that there are significant differences within the observed areas in all the characteristics.

Farms outside less favoured areas have a slightly larger size and employ more workers. However, LFA farms need rather more materials, energy and capital than farms outside LFAs, which can be expected due to the handicaps of less favoured areas.

We also focus on the LFA subsidies in each area (see Table 2); the LFA subsidy totals are similar – from EUR 40,229.33 to EUR 61,348.57 per farm. The highest subsidies are obtained by only two farms, which are in area H1 (above 800 m.a.s.l.), because this area is highly disadvantaged by altitude compared with farms in lowlands. The lowest subsidies are in the S area – this area includes farms with the specific disadvantages mentioned above. All the areas have minimum subsidies of zero because in at least one year they did not obtain any payments (they may not have applied for subsidies or due to the observed period they may not have been classified as being in a less favoured area at that time).

Table 2 LFA subsidy average in each LFA in EUR (EUR 1 = CZK 27.425)

	Farm	*Mean*	*St.dev.*	*Min*	*Max*
H1	2	61,349	110,633	n/a	524,991
H2	3	50,009	84,357	n/a	156,881
H3	7	46,326	69,078	n/a	123,323
H4	8	48,486	57,080	n/a	155,355
H5	3	45,319	54,751	n/a	49,867
OA	4	42,960	60,715	n/a	270,570
S	8	40,229	53,988	n/a	169,832

3. Results

Table 3 provides the estimated parameters of the IDF. All the first-order parameters are significant even at the 1% significance level. As far as the theoretical consistency is concerned, the estimated model implies that the estimation should inherit the properties of an input distance function.

Table 3 Parameter estimate

Variable	*Coeff.*	*SE*	*P* [|*z*|>*Z**]
Time	0.0148***	0.0031	0.0000
Y1	–0.2526***	0.0275	0.0000
Y2	–0.0256***	0.0128	0.0453
X2	0.4619***	0.0337	0.0000
X3	0.0447***	0.0130	0.0006
X4	0.2033***	0.0375	0.0000
TT	–0.0084***	0.0022	0.0001
Y1T	–0.0090***	0.0023	0.0001
Y2T	–0.0019***	0.0007	0.0121
Y11	–0.0739***	0.0304	0.0149
Y22	–0.0002	0.0030	0.9408
Y12	–0.0188***	0.0039	0.0000
X2T	0.0004***	0.0001	0.0000
X22	0.1601***	0.0553	0.0038
X33	0.0190**	0.0079	0.0156
X44	0.0979**	0.0481	0.0417
X23	–0.0417**	0.0209	0.0459
X24	–0.1316***	0.0510	0.0100
X34	0.02879	0.0186	0.1210
Y1X2	0.0383	0.0277	0.1662
Y1X3	0.0109	0.0103	0.2906
Y1X4	–0.0283	0.0223	0.2059
Y2X2	–0.0268***	0.0062	0.0000
Y2X3	0.0052*	0.0028	0.0645
Y2X4	0.0210***	0.0071	0.0032
Sigma	0.2110***	0.0004	0.0000
Lambda	7.0035**	4.5771	0.0474

Note: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

The input distance function must fulfil the following conditions: symmetry, monotonicity, positive linear homogeneity, non-decreasing and convex in outputs and decreasing in inputs. These requirements imply: $\beta x_j > 0$ and $\beta y_m < 0$ for $j = 2, ..., 5$

and $m = 1, \ldots, 3$. Table 3 shows that these conditions are met.

Since all the variables are normalized in logarithms by their sample mean, the first-order parameters can be interpreted as elasticity of the IDF with respect to the output and as the shadow value share with respect to the inputs on the sample mean. As can be seen from Table 3, the input share of capital is the lowest (0.0447), the input share of land is the highest (0.4619), the elasticity of the output is about 0.2526 and the elasticity of the support payment is 0.0256. That is, the share of capital in the total cost is only 5%; however, the share of land is about 46%. This reflects the absence of innovations in milk production connected with capital market imperfections, especially at the beginning of the analysed time period. This result was also confirmed by Čechura et al. (2014). The parameter lambda is highly significant and greater than one. The variation in u_{it} is more pronounced than the variation in the random component v_{it}. This indicates that most of the deviation from the border of the input requirement set is due to technical inefficiencies rather than random shocks.

The average technical efficiency is above 94% in each area (see Table 4), which suggests that farmers highly exploited their production possibilities. All the LFA farms have similar averages, but the farms in H1 exploited their production possibilities slightly more than the others – 94.24%. The fact that the farms in H1 have the highest average technical efficiency is surprising. We assumed that the technical efficiency would rise from H1 areas to N areas, in accordance with Sojková. The highest technical efficiency in the most disadvantaged mountainous area could have been influenced by breeding sheep in H1 – sheep and cows are not divided in the financial statements that we use for our calculations. The higher technical efficiency in mountainous areas could also have been influenced by the cow breed farmed. Czech mottled cattle are more common in highland areas because of their better milk characteristics – higher fat and proteins and shorter lactation interim; however, the milk yield is lower than that of Holsteins. In mountainous areas grazing suckler cows are also more frequent, which can lead to higher technical efficiency.

Table 4 Comparison of technical efficiency – inside and outside LFA areas

	Mean	St. Dev.	Min	Max
H1	0.9424	0.0200	0.9349	0.9870
H2	0.9418	0.0201	0.9415	0.9885
H3	0.9411	0.0199	0.9306	0.9891
H4	0.9411	0.0194	0.9316	0.9867
H5	0.9417	0.0199	0,9286	0.9863
OA	0.9404	0.0194	0.9307	0,9862
S	0.9412	0.0201	0.9297	0.9895
N	0.9417	0.0197	0.9294	0.9953

The highest technical efficiency is in the area outside LFAs – 99.53% in maximum. Our calculations suggest (the standard deviation is around 0.2%) that there are no big differences within LFA areas or between LFA and outside LFA farms. The disparities are slightly higher only in the S and H2 areas.

Absolutely the lowest technical efficiency is in the H5 mountainous area – 92.86% (this area also accounts for the lowest LFA payments and smallest technical efficiency change, which suggest that the situation is stable but that it could be improved).

The ability of farms to change inputs into outputs is an important part of profit creation. Table 5 represents the average profits in less favoured areas and outside those areas with LFA subsidies per worker. If we compare the profit of farm that are not disadvantaged and the profit of LFA farms, we can see that farms outside the area have a higher profit than handicapped farms.

Table 5 Calculated profit per worker in EUR (EUR 1 = CZK 27.425)

	With subsidies	Without subsidies
H1	2,542.29	–16,846.34
H2	20,838.29	4,164.54
H3	–1,051.36	–10,447.08
H4	800.80	–27,274.60
H5	–19,733.70	–35,829.69
OA	1,116.40	–6,215.37
S	–1,752.45	–24,747.62
N	3,271.31	3,271.31

Only farms in area H2 stand out, due to one farm inside the LFA that does not obtain any LFA subsidies (farm Gajďak spol., s.r.o.) and other farms inside H2 (Zefa Volary, s.r.o. and Zefa Zbytiny, s.r.o.) having higher incomes than other farms (these could have been caused by the data that we used – the incomes obtained from financial statements may also contain incomes from activities other than dairy farming). Those farms in the area have a positive profit. A negative profit even with LFA subsidies is observed in areas H3, H5 and S – these three areas obtained the lowest subsidies of all the farms within less favoured areas.

It is apparent that withdrawing the LFA subsidies caused a significant profit drop. The decrease is high in all the areas. Only one area (H2) is not in minus numbers due to the reasons mentioned above. The largest drop was calculated in area H5, followed by areas S and H2. The drop suggests that all the LFA areas are dependent (some farms more than others) on subsidies and that LFA payments are an important part of farms' incomes. That is, Czech dairy farms are significantly dependent on LFA subsidies.

A detailed analysis of the contribution of LFA subsidies to the farm profit is presented in Tables 6 and 7.

Table 6 Calculated profit with LFA subsidies in thousand EUR (EUR 1 = CZK 27.425)

	Mean	St. Dev.	Min	Max
H1	170.239	380.457	–384.632	892.549
H2	382.505	325.652	–18.625	1,479.558
H3	15.976	138.969	–216.226	542.722
H4	–166.220	295.212	–916.813	1,192.705
H5	–24.120	70.240	–163.074	147.961
OA	233.258	698.297	–655.718	1,815.050
S	93.463	358.957	–363.938	1,403.638
N	143.603	400.023	–472.706	1,901.604

Table 7 Calculated profit without LFA subsidies in thousand EUR (EUR 1 = CZK 27.425)

	Mean	St. Dev.	Min	Max
H1	–302.233	106.069	–442.297	–191.212
H2	121.669	148.907	–43.938	571.851
H3	–110.717	76.167	–216.263	230.921
H4	–464.740	343.293	–1,272.634	600.802
H5	–109.134	67.558	–297.721	–17.794
OA	–171.131	355.579	–947.092	481.130
S	–84.118	220.540	–363.938	492.397
N	143.603	400,023	–472.706	1,901.604

We can see that even with the subsidies all the areas had farms that experienced a negative profit at least once – this could have been caused by many factors, for example the international crisis in 2009, which led to a lower milk price and a lower income for farms. The negative profit could also have been due to missing LFA payments in some years. Absolutely the lowest profit can be seen in farms in the H4 area followed by OA. Absolutely the highest profit is observed in a farm outside less favoured areas, but the highest profit inside LFA areas is in OA. Other less favoured areas had one of the lowest and one of the highest profits of all the farms – this suggests big differences between farms in the area (the differences are also verified by the standard deviation, which is the highest of all the areas).

If we compare the profits without LFA payments, we can see that some characteristics change. The highest and lowest profits are still in the same areas (the highest outside LFAs, the lowest in H4). Interesting is the change in the standard deviation; the biggest differences are now between farms outside less favoured areas followed by the other areas and the H4 area. The smallest differences between farms are in areas H3 (there are 7 farms, and the drop in the standard deviation suggests that the LFA payments are not equally distributed and that some farms obtained higher LFA subsidies than the others) and H5 (there are also minor differences in LFA subsidies – this may mean that farms inside the area are similar and that they obtain quite narrow LFA payments – the area contains three farms).

We can also suppose that the LFA subsidies contributed to the equality of profit distribution. However, the Gini coefficient for less favoured areas (if we exclude areas outside less favoured areas) with the LFA payments is 0.2723 and without the LFA subsidies is only 0.1920. However, if we calculate the Gini coefficient including farms outside less favoured areas, the profit with LFA subsidies is 0.185991 and that without LFA payments is 0.182859. The lower value of the Gini coefficient suggests that the profit is distributed more equally (more *fairly*) between the dairy farms in the sample when the LFA subsidies are not included. This indicates that the LFA subsidies did not reduce the profit disparities between farms in disadvantaged areas (we can see a better distribution of profits if the LFA subsidies are excluded). However, if we include farms outside the LFAs in the calculation, we can see that the LFA subsidies do not change the distribution much and that the profit disparities are even lower than if the outside LFA farms are excluded.

Tables 8 and 9 present the mean of the components of profitability for dairy farms in LFAs and non-LFAs.

The output growth change (see Table 8) is negative in most of the areas (the lowest component is in the H1 area (–11.29%) and the highest is the S area (0.34%)) – only farms with specific handicaps and farms outside less favoured areas have a positive value of the component. The output price growth change is positive in all the observed areas and is between 0.46% (S) and 3.37% (H1), which is a good sign for all the farms. The input price growth change is not significant, and it is also positive in most of the areas (only the farms in H3 and outside LFAs have negative growth of the input price). The input price change is between –0.96% and 1.04%.

The technical change component in Table 9 only grows positively and can be found between 0.59% (H1 area) and 2.08% (the H4 area). That is, the technological progress is the smallest in the most disadvantaged area. Absolutely the smallest technical change component is shown in the H1 area and absolutely the highest in the H4 area. The mean of the scale component in each area is mostly negative (from –3.36% to –0.16%); only 2 areas achieved a positive change of this component (H1 4.64% and farms outside the LFAs 0.5%). This means that only those 2 areas are moving towards the optimization of production. The rest of the less favoured areas do not produce with optimal returns to scale.

Table 8 Calculated mean of the components of profitability change in LFAs and outside LFAs[2]

	OGC	OPGC	IPGC	PC
H1	–0.1129	0.0337	0.0104	–0.2119
H2	–0.0040	0.0215	0.0011	0.0318
H3	0.0020	0.0187	–0.0011	0.0358
H4	–0.0023	0.0166	0.0013	0.0337
H5	–0.0041	0.0218	0.0012	0.0175
OA	–0.0142	0.0134	0.0078	0.0228
S	0.0034	0.0046	0.0028	–0.0083
N	0.0031	0.0158	–0.0096	0.0444

Table 9 Calculated mean of the components of profitability change in LFAs and outside LFAs[3]

	TC	SC	MUC	TEC
H1	0.0059	0.0464	–0.1787	0.0011
H2	0.0176	–0.0336	0.0287	–0.0014
H3	0.0107	–0.0142	0.0148	–0.0015
H4	0.0209	–0.0059	0.0016	–0.0001
H5	0.0074	–0.0016	0.0007	0.0001
OA	0.0171	–0.0207	0.0305	0.0003
S	0.0131	–0.0134	–0.0132	–0.0026
N	0.0173	0.0050	–0.0105	0.0005

The results of the mark-up components differ, and three areas experienced a negative change of the component (from –17.78% to –1.33%). The largest negative change of the mark-up component appears in the H1 area, which means that the farms in this area lost their market power. The rest of the areas have a positive mark-up component from 0.07% to 3.05%. The technical efficiency is steady (according to Table 4 and Table 9). The change is only from –0.26% in the S area to 0.11% in the H1 area.

Finally, the profitability change in Table 8 is between –21.19% in the H1 area and 4.44% outside the less favoured areas. We can conclude that the farms located in the most disadvantaged areas lost their position from the profit creation point of view. This was caused especially by the loss of market power, which could be connected with the quality of products, and by the output quantity connected with the structural change in cow breeding.

4. Discussion

We found that there are small differences between the technical efficiency of farms in LFAs and outside LFAs. Similar results were obtained by Sojková (2007). Moreover, farms in LFAs reached higher technical efficiency levels than farms outside LFAs. Small differences between farms operating in LFAs were also observed by Čechura (2014) – the technical efficiency differs significantly only between farms above the 1000 hectare size (the observed farms in our research had only around 650 ha).

The profit of farms located in LFA areas depends significantly on LFA subsidies. A similar result was obtained by Koloszko-Chomentowska (2010). This applies to all the LFA areas. However, the highest level of dependency can be found in H1 and OA. According to IEEP (2006), dairy farms in LFAs are less dependent than farms with other specializations. Further research could be conducted for LFA farms in the Czech Republic, because, according to our results, some mountainous farms' profit is more dependent on subsidies than the profit of farms with specific handicaps.

We also observed that the LFA compensation payments reduce the difference between the profit generated by companies in less favoured areas and that gained by companies outside; however, it is not fully compensated, and Štolbová (2008) also observed such a relation. She found dependence between the share of grasslands, the size of the farm and the amount of LFA subsidies – some farms in mountainous areas and areas affected by specific handicaps may have received a higher level of LFA payments than is necessary to compensate for the existing disadvantage. It would be interesting to study this aspect with our dairy farm sample as well.

In our previous work (Maxová and Žáková Kroupová, 2015), we found a positive correlation between LFA subsidies and increased technical change, which opposes Sipiläen and Kumbhakar's (2010) foundation that agricultural subsidies negatively affect technical change. This points out the positive impact of LFA subsidies on investments. As Ciaian and Swinnen (2009) mentioned, subsidies provide an additional source of financing. This was confirmed again in this paper.

When we focus on the rest of the subsidies, the simultaneous increase in SAPS and the output price strengthened the profitability of milk producers. The positive contribution to the profitability increase was

[2] PC – Profitability Change, OGC – Output Growth change, OPGC – Output Price Growth change, IPGC – Input Price Growth change

[3] TC – Technical Change, SC – Scale Component, MUC – Mark-up Component, TEC – Technical Efficiency Change

also pronounced in the case of the mark-up component. A non-zero mark-up component implies that some market imperfections exist on the milk market. Moreover, this imperfection is significantly connected with the LFA and the other subsidies' change as well as with the quota change. This shows that agricultural policy instruments can lead to market distortions (as also mentioned by Brooks et al. (2008)).

A significant negative correlation can be found among the scale component and the LFAs, the other subsidies and the quota changes. Similar results were obtained by Rizov et al. (2013). Finally, the profitability change as a whole is positively correlated with SAPS and LFA subsidies, which are an additional income for milk producers and significantly contribute to their profitability. A similar result was obtained by Chrastinová and Burianová (2009) for Slovak farmers.

5. Conclusion

The aim of this work was to compare profitability and technical efficiency in LFA areas and to compare those results with farms outside LFAs. We also studied the influence of LFA subsidies on profitability.

We observed that LFA subsidies influenced farms' profit greatly in the researched period of 2004–2013 and that some farms would not have made a profit at all without the LFA payments (the profits of farms in mountainous areas – H3, H5 – and farms with specific handicaps – S – were influenced the most by withdrawing the subsidies, which suggests their high level of dependency). Moreover, the subsidies contributed positively to more equal distribution of the profit of LFA farms. The highest LFA payments were in mountainous areas (H1–H5), then in other LFAs (OA, OB), and the lowest were in areas with specific handicaps. However, some farms were able to generate a profit even without subsidies (a farm in a mountainous area and one outside LFAs), and some farms in mountainous areas were not able to generate a profit at all.

All the farms greatly exploited their productive possibilities, regardless of whether the farm is inside or outside LFAs. In addition, we did not observe big differences between LFA farms or between farms inside less favoured areas and farms outside less favoured areas. Moreover, farms in LFAs exploited the production possibilities even more than farms outside LFAs.

We also observed that all the farms are progressing technologically. However, only two areas are moving towards technical optimization.

However, we found some differences between LFA areas and not handicapped areas in the profitability components. The output is decreasing in LFA areas, but in non-LFA areas (and in areas with specific handicaps) it is increasing. We also concluded that some farms are losing their market power (farms in the H1 area, farms with specific handicaps and farms outside less favoured areas). Those farms (except those outside LFAs) also experienced a decrease in their profit during the observed period.

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