Productivity and Profitability of the Czech Agricultural Sector After the Economic Crisis

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Abstract: - In light of the recent economic crisis, a particular emphasis has been placed on the measurement of productivity and performance of agricultural sectors worldwide. This article deals with the assessment of the performance of the Czech agricultural sector using three measures: multifactor productivity, economic value added, and financial performance. The authors also compared the development of the values of these indicators with the overall economic growth of the Czech economy. No significant relationship between the development of the agriculture and economy has been found. This finding is in agreement with the idea that agricultural growth does not necessarily move in the same direction as the GDP growth. The authors also observed a sharp drop of performance in 2008/2009 which has been due to the economic crisis which has hit all Czech, but also foreign industries and sectors. However, in recent years, the performance of the Czech agricultural sector has been increasing which suggest that the sector is recovering from the economic crisis.

Key-Words: -Total factor productivity; economic value added, financial performance; agriculture; Czech Republic.

1 Introduction

Increasing productivity of agriculture by promoting technical innovation and ensuring optimum use of factors of production belongs to the initial objectives of Common Agricultural Policy outlined in the Treaty of Rome [9]. A sustainable growth of agricultural sectors and their productivity is an important goal of governments worldwide since agriculture represents an important sector of the economy and provides inputs for other industries. The agricultural sector affects directly and indirectly a significant part of a country's population and its wealth, especially in rural areas, thus playing several important roles. The production role is associated with provision of sufficient quantities of affordable and safe products, not only for the needs of food-processing industry, but also as inputs for other industries, such as biofuels, pharmacy or textile industry. The social and demographic role is related to the generation of employment opportunities and maintaining standards of living especially in the countryside and rural areas. The ecologic and landscape role is associated with the control of pollution and creation of a cultural landscape thus protecting the environment.

At the same time, a significant emphasis has been placed on productivity since due to environmental policies and urbanization, the arable land is becoming a limited input factor in most developed countries. Other approaches to measuring performance involve financial performance indicators or economic value added (EVA) measurement.

In this article, the authors estimate the multifactor productivity development of the agricultural sector in the Czech Republic and compare it its financial performance and economic value added creation. The differences and implications arising there from are also discussed.

2 Measuring Performance of Agricultural Sector

The output of an agricultural sector may be measured directly in physical units or indirectly in monetary value. The measurement of physical units such as tonnes of wheat is a theoretically sound approach (see e.g. [3]) but it is not always feasible because agriculture encompasses many heterogeneous activities, ranging from animals, plants or fungi cultivation, and the outputs are used

not only in food processing industry, but also biofuel, medicinals and other industries.

A more frequent approach is to measure the output of agriculture by monetary units such as value added or gross output. While the gross output is represented by the monetary value of all produced outputs, the value added is the difference between the value of the production and the value of intermediate inputs. Sometimes, the "final output" measure is used, which is obtained from the gross output by subtracting the value of agricultural inputs only (see [25]).

In the Czech agricultural sector, the productivity has been measured by various approaches in the prior research. Among others, researchers have used total factor productivity method ([6], [17]), data envelopment analysis (DEA, see e.g. [20], [1], [28]) or stochastic frontier analysis (SFA, see e.g. [12], [24]). Each of the approaches has its advantages and disadvantages. One of the possible inconveniences of econometric/mathematical programming methods (especially DEA and SFA) is the fact that they require the estimation of distance frontier function. Thus, when the sample of data is too small, the estimation of frontier may be biased and an unacceptably large share of the sample may virtually seem to be fully efficient. In the case of a small number of observations, indexed-based approaches may become more practical since they can be based on two observations only [17].

The technical efficiency in Central European agriculture has been measured from various viewpoints. The average score of technical efficiency is around 90% in Czech agriculture, so technical inefficiency is a significant phenomenon in Czech agriculture (Čechura, 2010). Latruffe et al. (2004) analyzed technical efficiency and its determinants for a panel of Poland specialized crop and livestock production before EU accession. Authors compare DEA with Stochastic Frontier Analysis (SFA). They find out that livestock farms are more technically efficient than crop farms. Large farms are more efficient than small farms. Bakucs et al. (2010) evaluate technical efficiency of Hungarian farms before after EU accession. They conclude that increase of subsidies in post-accession period contributes to lower efficiency of Hungarian farms.

Productivity measurement is often carried out from two perspectives: total factor productivity (TFP) which takes into account all possible inputs and outputs of an industry (firm, process, see. e.g. [16]), multifactor productivity (MFP) which deals with the relationship between output and multiple input factors, and partial factor productivity (PFP) which deals with the productivities of individual inputs. Perhaps the most popular PFP measure is the labor productivity which is often used in comparisons of productivity across sectors or economies. At the same time, labor productivity reflects the ability to acquire income through sale of agricultural goods or agricultural production (see [3]). However, partial factor productivity analyses should be accompanied with a more rigorous general analysis since a possible substitution among inputs has to be taken into consideration.

Total factor productivity is often seen as a measure of technological and human capital development. Nelson ([21] and [22]) found out that there is an important relationship between capital formation, labor allocation, technical progress on one side, and productivity on the other hand. The inputs for productivity analyses generally include land, labor, and capital, sometimes also accompanied by materials, energy and services (KLEMS). Since the amount of land does not change considerably, it is often omitted from the analysis since the year-to-year change (index) of this factor is negligible. The production function then most often contains only two variables: labor (L) and capital (K).

At the same time, productivity is not the sole possible measure of an industry's performance. A popular and straightforward, yet simplistic approach is based on measuring performance using financial indicators, especially profitability ratios such as return-on-assets (ROA) or return-on-equity (ROE). A more modern approach involves measurement of economic value added (EVA, see e.g. [30]) which is an indicator developed by Stern Stewart & Co. in 1993 and unlike classical financial ratios, it captures the cost of equity, which is usually considered to be the most expensive portion of a company's capital.

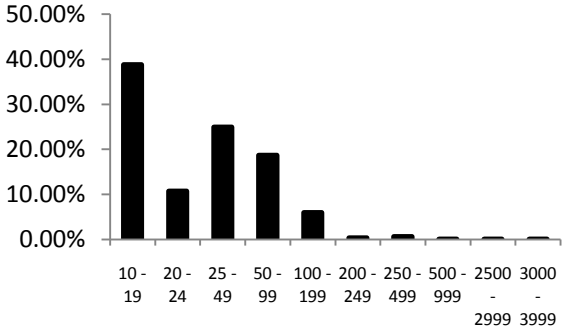
Machek and Špička[19] found that productivity of agriculture does not necessarily follow the domestic economic cycle, since the output of the agricultural sector is largely dependent on foreign demand as well as weather conditions and other factors. In this article, the authors will examine whether an increasing multifactor productivity has been accompanied by a stronger financial performance and economic value added (EVA) creation and a larger GDP growth.

3 Data Characteristics

To collect data on the Czech agricultural sector, the authors used the Albertina database which contains information about more than 2 700 000 subjects with registered ID in Czech Republic. The authors focused on companies with complete and correctly disclosed data having more than 10 employees operating in the agricultural domain. The total sample contained 2 237 company-years.

In this section, the authors present the basic characteristics in terms of number of employees, legal forms and geographical location in the Czech Republic. The period under consideration was 2007-2012.

Fig. 1: Classification according to the headcount (2007-2012)



Source: Albertina database, own calculations.

Figure 1 suggests that most companies belongto the class of small enterprises with less than 50 employees. A minor part of agricultural companies belongs to the class of medium-sized companies (50-250 employees), while the class of large-sized companies is negligible.

It is also possible to analyze the nature of legal forms of Czech agricultural firms (see Table 1). Most agricultural companies are privately held. The major portion is represented by limited companies (39%), followed by stock companies (25.3%), cooperatives (21.3%) and private entrepreneurships (12.7%). The proportion of other legal forms, such as allowance organizations, co-partnerships, or state companies, is non-significant.

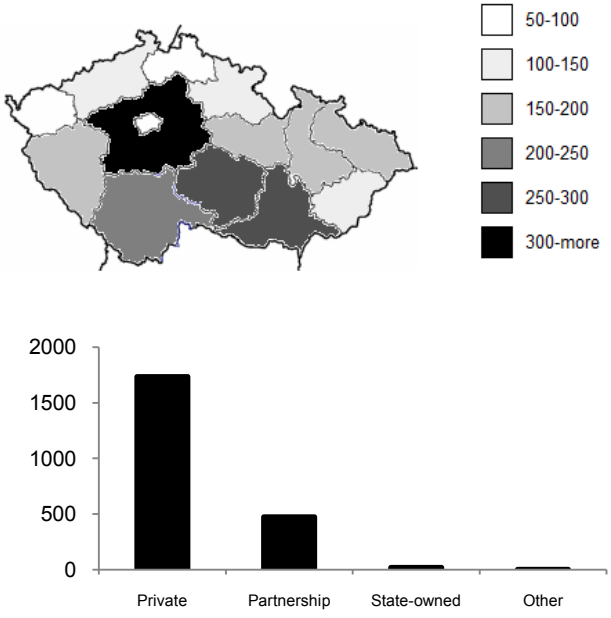
Table 1: Legal forms of Czech agricultural companies (2007-2012)

Legal form	Count
Limited liability company	873
Stock company	567
Cooperative	476
Private entrepreneur	284
Allowance organization	16
Co-partnership	7
State company	5
Others	9

Source: Albertina database, own calculations.

Unsurprisingly, most Czech agricultural companies are located in rural areas, as depicted on the map on Figure 2 (absolute numbers). Central Bohemia is the area with most agricultural firms (13.6%), followed by Southern Moravia (12.38%), Vysočina (11.18%) and Southern Bohemia (10.91%) regions. The figure again confirms that 77% of the companies are privately-owned, while 21.3% are owned by partnerships and 1% are state-owned. Other forms of ownership are negligible.

Fig. 2: Location of Czech agricultural companies and Ownership Form



Source: Albertina database, own calculations.

4 Methods

In order to evaluate the performance of agricultural companies, three groups of indicators have been chosen:

- Multifactor productivity (MFP);
- Financial profitability;
- Economic value added (EVA).

4.1 Multifactor productivity

Multifactor productivity (MFP) is the ratio of an index of agricultural output to an index of agricultural inputs. In economics, it is often measured indirectly: the amount of growth not explainable by the increase of input factors (also referred to as Solow residual). MFP includes effects of many factors including technology development, economies of scale and scope and innovations. In this article, the classical MFP formula has been used.

$$\frac{Y_1}{Y_0} = \frac{A_1}{A_0}\left(\frac{K_1}{K_0}\right)^{1-\alpha}\left(\frac{L_1}{L_0}\right)^{\alpha} \qquad (1)$$

where Y_1/Y_0 represents the index of gross value added (in constant prices), K_1/K_0 is the index of net assets in constant prices, L_1/L_0 is the index of working hours, α is the ratio of labor compensation over gross value added and A_1/A_0 is the multifactor productivity (see e.g. [26]).

4.2 Financial profitability

Financial performance is often measured by profitability ratios. These ratios are used to evaluate a company's ability to generate earnings compared to its expenses incurred during a period of time. In order to measure the financial performance of the Czech agricultural sector, the authors employed well-known measures of profitability: return on assets (ROA), return on equity (ROE) and return on sales (ROS). Generally, such ratios should be accompanied by a deeper financial analysis [23].

$$\mathrm{ROA} = \frac{\mathrm{EBIT}}{\mathrm{Assets}},\ \mathrm{ROE} = \frac{\mathrm{EAT}}{\mathrm{Equity}},\ \mathrm{ROS} = \frac{\mathrm{EBIT}}{\mathrm{Sales}} \qquad (2)$$

4.3 Economic value added

Perhaps the most contentious is the measurement of economic value added which involves measurement of the cost of equity which should reflect the required rate of return to equity investors. One of the possible formulas to calculate economic value added (EVA) is

$$EVA = (ROE - r_e) \times E \qquad (3)$$

where*ROE* denotes return on equity (net earnings over equity), *E* denotes equity and r_e denotes cost of equity. All variables except r_e can be obtained from financial statements of the companies. However, the estimation of the cost of equity can be carried out using multiple methods. In this article, the authors used the CAPM model to estimate r_e(see e.g. [27]). Under this approach, the cost of equity is estimated as

$$r_e = r_f + \beta_{lev} ERP \qquad (4)$$

wherer_f is the risk-free rate, β_{lev} is the levered (equity) beta and *ERP* denotes equity risk premium, the difference between expected market return and the risk-free rate. While the values of yearly country-specific *ERP* and unlevered betas β_{unl} were obtained from the database of prof. Damodaran[8], the risk-free rate was proxied by the average return on Czech 10-year government bonds [5]. The unlevered betas were converted into levered betas using the formula

$$\beta_{lev} = \beta_{unl}\left[1 + \frac{D}{E}(1-t)\right] \qquad (5)$$

5 Results and Discussion

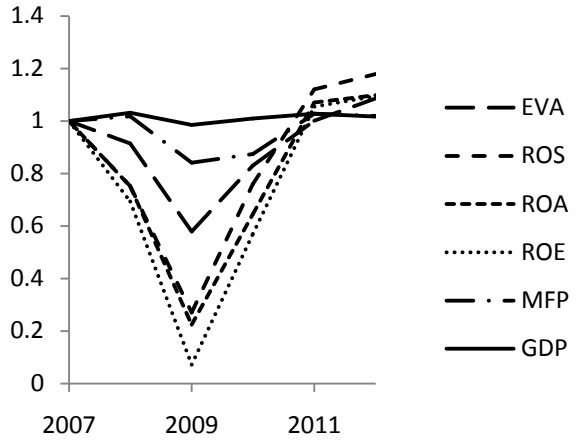
Before the interpretation of results, it should be noted that the agricultural sector as a whole often represents an aggregation of heterogeneous activities, and that the only output taken into account was the gross output, which means the authors don't work with physical units and the real productivity may be biased due to changes in output and input prices.

Agriculture is characterized by a relatively high degree of competition, which is generally accompanied by a higher level of productivity than the one in more concentrated markets (see e.g. [15]). The main sources of gross output volatility in agriculture include the fluctuation of prices – at both foreign and domestic levels – and year-by-year changes in yields as the result of changeable weather conditions. Among other factors influencing output volatility, we may mention the currency exchange rate which could be mitigated by the adoption of euro [10][11]. At the same time, partially or fully decoupled payments may serve as a "financial pillow" thus increasing the level of the

farmers' income and extending the companies' decision-making possibilities [29].

On Fig. 3 and Tab. 2, the development of performance indicators in the period 2007-2012 in terms of fixed-base indexesis illustrated. At first glance, a certain dependence among the measures used may clearly be seen, especially in terms of profitability and EVA. The authors also compared the development of performance indicators with the overall growth of the Czech economy measured by the GDP growth [5].

Fig. 3: Development of performance indicators (fixed-based indexes)



Source: Authors

Table 2: Development of performance indicators (fixed-based indexes)

	EVA	ROS	ROA	ROE	MFP	GDP
2007	1.00	1.00	1.00	1.00	1.00	1.00
2008	0.91	0.75	0.75	0.69	1.02	1.03
2009	0.58	0.27	0.22	0.07	0.84	0.98
2010	0.83	0.76	0.65	0.57	0.87	1.01
2011	1.00	1.12	1.07	1.05	1.03	1.03
2012	1.09	1.18	1.10	1.09	1.02	1.02

Source: Authors

In the first year, the multifactor productivity followed the GDP growth, as opposed to other indicators which decreased considerably. The drop of performance has been significant in 2008/2009, especially in terms of profitability. This negative development of performance has been followed by a substantial increase in the next year. Since 2010, all indicators have been growing. Apparently, the economic cycle does not move exactly in the same direction as the performance measures and vice versa which is consistent with prior findings ([17], [19]). Indeed, since the agricultural sector provides basic inputs for the peoples' livelihood and is highly dependent on changing natural conditions, there should be only a relatively low sensitivity to the overall economic growth. The output of the Czech agriculture also heavily depends on foreign demand. On the other hand, there is a certain dependence of economic growth among European countries; for instance, the Czech economic cycle is largely dependent on the development of the German economy.

On Fig. 3, it's possible to clearly identify the negative impact of the 2008-2009 economic crisis. While the dependence on foreign economic development mitigates the effect on domestic economic growth on the industry's performance, the economic crisis has hit all neighboring countries thus having a certain impact on the Czech agriculture's performance. On the other hand, in 2007 and 2011, the agricultural enterprises in the Czech Republic attained the best economic results since the accession to the European Union. Even though EVA has been negative in all years under consideration, it seems that the Czech agricultural sector has been recovering from the economic crisis in recent years.

To enrich the analysis, the authors also determined the correlation coefficient between individual variables using the MATLAB software (see Tab. 3). Although the time series is not long enough, it is possible to see that the performance measures were not significantly correlated with the GDP growth. The correlation analysis also revealed that EVA is significantly correlated with profitability in terms of return on sales (profit margin), return on assets and return on equity. Return on sales is significantly correlated with the return on assets and return on equity. Multifactor productivity is not significantly correlated with other performance measures, although in theory, there could be some degree of dependence [14].

Table 3: Correlation coefficients

	EVA	ROS	ROA	ROE	MFP	GDP
EVA	1.00					
ROS	0.98*	1.00				
ROA	0.99*	0.99*	1.00			
ROE	0.99*	0.99*	1.00*	1.00		
MFP	0.89	0.82	0.88	0.88	1.00	
GDP	0.83	0.76	0.80	0.81	0.89	1.00

Note: * Significant at $\alpha = 0.05$

6 Conclusion

Agriculture is an important economic sector which affects directly or indirectly a significant part of a country's population. In recent years, a particular emphasis has been placed on the measurement of productive efficiency of this sector. In this article, the authors analyzed the efficiency development of the Czech agricultural sector using the following measures of performance: multifactor productivity measured by the Solow residual approach, economic value added, and financial performance measured by three profitability ratios: return on equity, return on assets and return on sales. The authors also compared the development of the values of these indicators with the development of the GDP growth.

No statistically significant correlation between the development of the economy and the above-mentioned performance indicators has been found. On one hand, the authors had only a limited time series, but on the other hand, this findings support the hypothesis that agricultural growth does not necessarily follow the overall economic growth due to its dependence on foreign demand and sensitivity to weather conditions. It was also possible to observe a sharp drop of all efficiency measures in 2008/2009 which has been due to the economic crisis which has hit not only Czech industries and sectors, but also foreign economies. However, in recent years, the performance of the Czech agricultural sector has been increasing which supports the hypothesis that the Czech economy has been recovering from the economic crisis. In should also be noted that a longer time period is needed to test the dependence more accurately. This will be one of the directions of the future research.

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