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On the profitability of Polish large agricultural holdings

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ABSTRACT

The aim of this study is to examine the impact of selected determinants on various categories of profitability in the Polish agriculture. To answer this question, we employed a unique panel of 78 entities. We found that subsidies had a negative effect on profitability of large farms. Moreover, they did not detect a significant impact of variables related to farm operator. Financial surplus to liabilities had a positive impact on both ROS and ROA. Moreover, the significance of using the risk management tools and shaping the ratio of rented land to total land are underlined as important managerial implications. Diagnostics of the model indicated the advantage of the models with fixed effects (FE) over the models with random effects (RE).

KEYWORDS

profitability, ROS, ROA, ROE, agriculture

JEL CLASSIFICATION INDICES

D22, D24, Q14, Q18

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1. INTRODUCTION

The agricultural sector in Poland, taking into account both the social and economic importance of farms, has still an important role in Poland.[1] The specifity of Polish agriculture relates to its bipolar structure which features both small family-owned farm households and large agricultural holdings. The prevailing agricultural model implies subtleties in designing agricultural policy instruments, i.e., various forms of subsidies. Large agricultural holdings[2] are playing an increasingly important role in the agricultural sector in Poland. According to the data collected by the Central Statistical Office in Poland (Główny Urząd Statystyczny, GUS), a significant number of mid-size farms (5–10, 10–15 ha) have been consolidated into larger units. The total number of large-sized farms increased from 7,422 (in 2002) to 9,822 (in 2011).[3] An opposite trend may be noted for small farms (1–2 ha), a significant decrease in their number (24%). This indicates a shift towards a more competitive market-oriented agriculture. From over 700,000 market-oriented farms about 300,000 entities are farms that operate as enterprises, maintain accounting (including profit and loss account) and pay income tax. They have an 80 per cent share in total agricultural output and even greater in agricultural exports. Such farms, in terms of area, equipment and productivity, do not differ much from the average European farms. In fact, the structural changes in Polish agriculture have accelerated. The results of the last Agricultural Census show that the share of large-sized farms was only 0.63%, while these entities operated 22.3% of farmland in Poland (GUS 2012). They certainly benefit from positive effects of economies of scale (Kulawik 2014).

Profitability is of great importance for farm managers, policymakers and researchers. Profitability in agriculture as a "specific sector" often depends on various variables related to external factors (e.g. agricultural policies, pricing), features of farming, and characteristics of farm operators. This motivates us to compare the determinants from research into non-agricultural sectors.

[1]More than 15% of the labour force work in agriculture, forestry and related sectors generating 5.4% of GDP in 2011. The total utilised area of an average farm (a sample from the Polish Farm Accountancy Data Network, FADN) was about 19 ha (data from 2011, EU FADN, 2018). Economic results of the Polish commodity farms indicated a continuous increase of net farm income from PLN 10.0 thousand into PLN 10.9 thousand in 2011.

[2]The category of "agricultural holdings" (according to FADN terminology) includes both legal persons (agricultural enterprises in the form of limited liability or joint-stock companies) and family-owned farms. In the developed and emerging economies, the so-called "agro-holdings" and other types of mega-farming operations play an important role in agri-food sector (Balmann et al. 2015). We focused on large farms that are strongly linked to agri-food markets. It should be clarified that large-sized (large) agricultural holdings (farms) are defined as agricultural entities with minimum 100 ha of utilised arable areas (UAA). However, in Poland there are two classifications of large farms: (1) over 100 ha and (2) over 300 ha (less frequent). Institute of Agricultural and Food Economics – National Research Institute – as provider of an empirical database – employs the first of the aforementioned classification.

[3]Results of the last agricultural census from 2020 will be published in the end of 2021. According to GUS data, in 2016 the share of larger farms ($\geq$ 50 ha) in the total number of farms (>1 ha) was about 2.3%. We focused our dynamics in the line with the research period in the empirical part.

Identifying the determinants of profitability and measuring the key rates of return, i.e., return on sales (ROS), on assets (ROA) and on equity (ROE),[4] along with current monitoring, should play a significant role in agricultural policy. It is known, for example, that low profitability is a sensitive problem for the Common Agricultural Policy (CAP). In the EU "despite the increase in size and the improvement of productivity, many farms depend heavily on direct payments" (European Commission. . ., 2010: 2). Moreover, in the agricultural sector farmers are exposed to "farm price-cost squeeze" (a situation in which "farm commodity prices fall and the costs of production rise"), which is caused by "the cyclical nature of agricultural markets". Farm profitability is correlated with "price ratio" (agricultural products sold/agricultural resources bought). Lags in production cycles (e.g., crop production) may partially explain the trends in prices that induce changes in farm profitability. Thus, as we have already stated, the aim of this paper is to examine the impact of selected determinants on various categories of profitability, i.e., ROS, ROE and ROA of Polish large (large-sized) agricultural holdings (with 100 ha or more of utilised agricultural area (AA)).

2. DETERMINANTS OF PROFITABILITY – LITERATURE REVIEW

Our review aims at identifying the determinants of profitability of entities operating in the non-agricultural sectors and at the farm household level. Identifying methodologies related to assessment of their impact on ROS, ROE and ROA indicators is the auxiliary goal of the literature review.

The growing number of papers, particularly in corporate finance, identifies the main categories of determinants of profitability, including macro, mezzo and microlevel. Numerous empirical studies, focussing mainly on non-agricultural sectors, indicate that there was a significant impact of business firm and industry-specific factors on profitability, although the available information on the firm-level determinants was much higher.

There are various levels of determinants of firm profitability, used mainly in panel models. On the other hand, Stierwald (2009) noted that such determinants at the sectoral level, including entry barriers, concentration and differences in productivity cannot be ignored. A significant part of the determinants of firm profitability relates to the type of business firm strategy. There are several papers on the relationship between export activity and the profitability of firms. Fryges – Wagner (2010) verified whether the export-sales ratio, describing the export activity of the German manufacturing firms, may have a significant impact on the business firm profitability.

Another area of research is the recognition of the relationship between the size of companies and their profitability. Goddard et al. (2005) found that a firm's size affected profitability negatively. There was a relatively strong positive relationship between market share and

[4]We dealt with several empirical studies from non-agricultural sectors where ROA, ROE (main proxy for financial efficiency), as well as ROS were presented and explored. As Nehring et al. (2015) indicated, Du Pont expansion model may be applied for analysis of the financial performance of farms. The aforesaid model is based on decomposition of ROE. ROA, ROE and ROS are useful measures for financial efficiency (for example, inequality ROE>ROS).
Current empirical studies (e.g., Boyd et al. 2007; Katchova 2010; Nehring et al. 2015) proved that ROE and ROA, in particular, are useful for assessment of financial performance in farm household. Additionally, from the perspective of our empirical studies the set of profitability indicators is analysed together with a significant role of ROE indicated.

profitability. Based on the panel data estimation techniques, the Greek economists Asimakopoulos et al. (2009) identified the significance of the determinants of profitability for the non-financial Greek firms. In line with the previous findings, their results confirmed that size, sales growth and investment had a positive influence on a firm's profitability. However, the impact of leverage and current assets on business profitability was strictly opposite.

It should be noted that a lot of academic inspiration drawn from non-agricultural sectors was transferred to agricultural economics. Regardless of the type of business, fundamental dependencies in economics and finance remain unchanged.

Profitability of the agricultural sector, including farms, is of great interest, taking into account the relationship with the natural environment (agriculture as a supplier of public goods), social interest and the maintenance of an adequate level of food security. This is reflected in the literature which aimed to identify the determinants of profitability or, indirectly, to present the mechanisms of shaping or interdependence with other economic and financial categories. An in-depth review study by Boyd et al. (2007) proposed the typology of literature on the determinants of profitability in agriculture and enumerated a body of American research papers related to the aforementioned dependency. They identified the following stream of research into this issue in the existing literature: (1) "combined financial ratio and management factor literature", (2) "management factor literature", (3) "industry and resource factor literature" (Boyd et al. 2007: 203–204). Nehring et al. (2015) explored the drivers of the profitability of the U.S. broiler poultry farms. They found that farm size, diversification, region, farmer age, and off-farm employment were the key determinants of business performance of broiler poultry farms in the United States. Sciascia et al. (2014) investigated the relationship between firm management (i.e., family management as a percentage of managers who are family members) and farm/business profitability (expressed by the level of ROE).

Ryś-Jurek (2013) found that, in the EU at FADN macro-regions, profitability indicators decreased along with the increase in the economic size of farms. "Agricultural holdings" located outside the less favoured areas were characterised by lower profitability. Various determinants, such as the size of the farm resources, indicate the effective use of these resources (the level of product sales prices, prices of production factors, climatic conditions and macro-economic policy of the government) (e.g., Zawadzka – Szafraniec-Siluta 2015). Machek – Špička (2015) investigated that ROS, ROA and ROE were strongly correlated with Economic Value Added (EVA) and Multifactor Productivity (MFP).

There are some empirical studies exploring more and less directly the nexus between agricultural policies and farm profitability. For example, Kropp – Katchova (2011) explored the relationship between decoupled payments and the financial efficiency of farms operated by novice farmers. Britz et al. (2012) simulated the impact of some scenarios of decoupled payments on the level of income at the EU regional level. To conclude, agricultural policies may affect (to a different degree) farm profitability. This depends on the type of the public support.

The impact of CAP subsidies on the profitability of large farms is complex. Therefore, the issues of allocation of capital and the distribution of income should be analysed (Rembisz (2008); Kulawik 2014; Góral 2015). The impact of the EU subsidies includes the positive change of liquidity, solvency and investment activity of farms (Kulawik 2014). This means that improving the financial potential of farms, so they can consider more ambitious strategies for restructuring. Subsidies also affect the market of factors of agricultural production, but they must also be analysed in the context of changes in the value of agricultural assets Góral (2016).

Similarly, Kropp – Katchova (2011) analysed the impact of subsidies decoupled from production on farmers' access to the offers of the financial sector. Direct payments improve liquidity and creditworthiness. There was a positive correlation between solvency ratios (repayment) of loans and grants received by the U.S. farmers. The impact of subsidies and their capitalisation are also reflected in the economic indices of agricultural holdings (Kulawik – Góral 2014). Similarly, Kropp – Whitaker (2011) noted that subsidies resulted in lower interest rates on short-term loans. This had a direct impact on the scale and profitability of production.

In the Polish agriculture, with a vast majority of family-owned farms, there are methodical difficulties in calculating profitability (e.g., the necessity of using estimations for the cost of the owner's/family's own work). Several Polish empirical findings focus on identifying trends in the profitability of farms (at the level of FADN macro regions, at sectoral level in Poland, and at farm level). Zawadzka – Szafraniec-Siluta (2015) noted that industrial enterprises had higher ROA (5.7%) than agricultural enterprises (5.1%) between 2006 and 2013. From 2009 to 2013, agricultural entities obtained a continuous increase in ROA, reaching a value 14.6 times higher at the end of this period than at the beginning. Positive changes in farm profitability were driven by an increase in economic surplusses, favourable changes in the structure of assets, and the EU subsidies. The specificity of the activity is of great importance for ROA, and the type of production is particularly important in farming. The Polish agricultural enterprises were characterised by a high share of fixed assets in the overall asset structure, although this level gradually reduced in subsequent years of the study. These studies have shown that the specificity of agricultural activity is of great importance for the profitability of assets (see Table 1).

Having analysed empirical studies related to non-agricultural and agricultural sectors, we identified the following research streams: (1) peculiarities of the nexus between the economic size and profitability (explored, for example, by Boyd et al. 2007), (2) the significance of the socio-demographics of farm operators in small family-owned farms, and (3) the type of production as the significant determinant of profitability. It should be noted that empirical studies related to non-agricultural sectors focus on the sector effect, e.g., "entry barriers, concentration and differences in productivity".

Our current review of literature in SME and agricultural finance indicates that there are some key methodological approaches for assessing the impact of particular factors on profitability indicators (mainly ROE and ROA are of great importance for financial management):

- OLS regression models based on single-year data (Gloy – LaDue 2003) – in particular in empirical studies that employ survey data;
- Panel regression models – mainly with lagged and dummy variables (Goddard et al. 2005)[5];
- Probit models (Katchova 2010).

Table 2 presents selected variables as the determinants for various measures of farm profitability. It should be noted that there are various levels of determinants in this respect.

[5]It should be noted that the FE (Fixed Effects) model approach is employed taken advantages in econometrics, including the violation of a "critical" modelling assumption that the regressor and the unit effects are uncorrelated –turns out to be an insufficient justification to prefer fixed over random effects (Clark – Linzer 2012: 28).

Table 1. Key features of Polish agriculture

Number of farms with an area of more than 1 ha, by area of agricultural land				
Area groups	**2002**		**2011**	
1–2 ha	517,040		391,864	
2–5 ha	629,850		563,698	
5–10 ha	426,869		342,060	
10–15 ha	182,685		158,981	
>15 ha	199,697		198,665	
Including 30–100 ha	44,072		52,183	
Including >100 ha	7,422		9,882	
Total number of farms (thous. ha)	1,956		1,583	
Utilised arable areas, UAA (thous. ha)	16,503		1,005	
Average area of UAA per farms	8.44		9.50	
Years	**Total of UAA [1,000 ha]**	**Labour input [1,000 AWU]**	**Capital input [million euro]**	**Value of production [million euro]**
2007	16,177	2,299	10,709	14,837
2008	16,154	2,299	10,631	14,964
2009	15,608	2,214	10,712	15,454
2010	15,535	1,915	10,339	15,090
2011	15,134	1,915	10,813	15,405

Source: Based on GUS data.

Determinants include the location of a farm, features of farms, farming technologies, agricultural policies, the financial condition of a farm, access to credit and insurance, and the characteristics of farm operators. From the perspective of large-sized farming, attention is paid to farming technologies that can be used in a flexible way. A plethora of determinants is relatively beyond a farm operator's control.

To conclude, the results of the empirical studies, based on farm- and agribusiness data, shed light on the statistical significance of a part of variables (for example, the size of entity or characteristics of farm operators). We identified some theoretical gaps that will be filled in the empirical section. First, the impact of subsidy (measured by, for example, subsidy rate) on profitability of large farms has not been explored in depth. The relationship between the size of the enterprise and its profitability was of particular interest in empirical examination of the

Table 2. The impact of the selected determinants of farm profitability

Variable	Expected sign	Example of studies
Macroeconomic conditions		
Year	Signifcant factor	Machek – Špička (2015)
Location of farms		
Region	+/− (this depends on region-specific characteristics)	Nehring et al. (2015)
Environmental restriction	+/−	Franks (2009)
Features of farm		
Farm size	+	Nehring et al. (2015)
Type of production	+ (crop production) +/− (animal production)	Katchova (2010) Ostapchuk et al. (2015)
Diversification	+	Nehring et al. (2015)
Legal type	+/− (as significant)	Ostapchuk et al. (2015)
Total rented farm area/total farm area	+	Kagan – Ziętara (2017)
Farming technologies		
Production technology	+ (modern technologies improve productivity, and as result, profitability)	MacDonald (2008)
Farm sustainability practices	+/−	Galioto (2017)
Fertilizers	+	Authors' assumptions
Asset Structure	+	Authors' assumptions
Agricultural policies		
Subsidy rate	−	Zakova Kroupova (2016)
	+	European Commission (2010)
Financial condition of farm		
Financial stress	−	Boyd et al. (2007)
Financial liquidity	−	Boyd et al. (2007)
Access to credit and insurance		
Debt (variables for financial structure)	−	Boyd et al. (2007)
Preferential credit	+	Ostapchuk et al. (2015)
Crop/livestock insurance	No effect (in the U.S).	Kirwan (2014).

(continued)

Table 2. Continued

Variable	Expected sign	Example of studies
Farm operator		
Age of farm operators	+ +	Gloy – LaDue (2003) Nehring et al. (2015) Katchova (2010)
Education of farm operator	– (not significant)	Gloy – LaDue (2003)
Off-farm employment	+ (off-farm operator) – (spouse off-farm)	Nehring et al. (2015)

Source: Own compilation.

finance of SMEs. Another research niche refers to the link between the type of production and the level of farm profitability. In particular, mixed production is of great importance given the use of diversification. Considering the above, we formulate the following research questions:

1. Do CAP subsidies affect profitability of the Polish large farms?[6]
2. Is the type of production (in particular, crop farming) a significant determinant of farm profitability?[7]
3. Do features of farm managers (age and educational background) have a significant impact on ROE?[8]

3. METHODOLOGY AND DATA

3.1. Methods

The paper estimates the regression function, which allows an assessment of the relationship between the analysed profitability and its determinants. The analysis of the set of variables was preceded by a detailed literature review, brainstorming and expert interview. We tried to avoid duplication of dependencies identical with the Du Pont model (finally not present in this paper).

[6]Although there is a growing body of studies related to the role of agricultural subsidies, only some of them refer to the nexus between CAP subsidies and profits (e.g., Zakova Kroupova 2016 or European Commission 2010). Subsidies are regarded as one of the important instruments of CAP and the high level of subsidies determines the specificity of the agricultural sector in the EU countries.

[7]The second research question refers to "industry and resource factor literature" that was noted by Boyd et al. (2007: 203–204). Moreover, non-agricultural literature proposed empirical analysis according to the industrial sectors.

[8]The third research question relates to the so-called managerial stream in literature: the manager's characteristics may affect the company's ability to generate profits, and thus its profitability, including ROE – an indicator that stakeholders are particularly interested in (e.g., shareholders, financial institutions). We presented selected results of studies in the U.S., but our empirical research was based on a sample of Polish large agricultural holdings.

Such a study would not bring any new values, and the regression analysis itself would be pointless.[9] Potential variables were grouped into the following subgroups:

- Farm characteristics are related to: farm access to production factors – share of leased farmland, number of employees, size of capital input; production costs, scale effects (production volumes), production type; share of preferential credits, share of borrowed capital, current liquidity, crop or livestock insurance (as premiums paid);
- Farm management process (organisational and management factors) – form of organisation, Herfindahl-Hirschman index (HHI);
- Characteristics of farm operator (age, the existence of a successor and the stage/phase of the family life cycle and the number of managers);
- The impact of agricultural policies – subsidy rates.

The research was carried out on panel data (a balanced micro panel of large-area farms in 2007–2011). Panel data allowed for the identification of the specifics of individual objects. Tracking many units in the subsequent periods may enable the causes of certain phenomena to be identified, or the dynamics of phenomena at the micro level to be followed. These models take into account the impact on the analysed objects of two groups of factors. The first group includes those that have the same influence on the formation of the phenomenon in all objects. The second group consists of those that specifically affect individual units of the study. There are two types of panel model, one with fixed effects (FE) and one with random effects (RE).[10]

The model's assessment is based on chi-square statistics, which in turn is based on the reliability function (LRT statistic – Likelihood Ratio Test) and *F* statistics (calculated on the basis of sums of squared deviations). For the REM model, the Lagrange multiplier test is carried out accordingly and the test statistic is LMT (Lagrange Multiplier Test). At low *P* (i.e., with test probability less than 0.05), the decomposition of a free term or a random component is considered legitimate. The choice between the FEM and REM model is made using the Hausman test *t* ($P < 0.05$ the FEM model is considered more reliable than the REM) (Baltagi 2008).

To verify the models' built-up on the micro panel, statistics such as R^2, standard error of residuals and sum of residual squares, statistics *F*, the chi-square test and the Hausman test were used. If the explanatory variables are not correlated with a random component, they can be considered as exogenous. We estimated both panel models assuming the constant effects (FEM) as well as models assuming the occurrence of the random effects (REM). Based on the results of the Hausman test, the REM models were rejected and only the results from FEM models (with constant effects) were left.

[9]Selection was based on empirical dependencies (detected in a literature review) and logical assumption is typical for providing a set of literature review. We investigated into direction and statistical significance of dependencies between profitability ratios and various economic and financial categories (semi-metanalytic approach was employed).

[10]We use panel models with FEM and models with variable REM:
FEM:
$y_{it} = \alpha_i + \beta x_{it} + \varepsilon_{it}$ (1)
α_i – individual effect of observation.
REM:
$y_{it} = \alpha_i + \beta x_{it} + \varepsilon_{it} + \gamma$ (2)
where: γ– constans; ϑ_{it} –random factor and $\vartheta_{it} = \alpha_i + \varepsilon_{it}$

3.2. Data

The present study was carried out on a random sample of large farms (exceeding 100 ha) surveyed annually by the Economics of Farm Holdings Department at the Institute of Agricultural and Food Economics – National Research Institute (IERiGŻ-PIB). Most of them maintain comprehensive book-keeping and implement new production technologies. Our empirical data were derived from these surveys, compiled over many years.[11]

The panel was constructed for a period covering five years (2007–2011). The sample amounted to 78 agricultural holdings each year, of which 36 in the form of farms of natural persons and 42 as legal persons. A data pool was created for 5 years, resulting in a total of 390 observations. It should be emphasised that the average area of the surveyed farms was larger than the average for the group of entities operating on an AA in excess of 100 ha, as specified by the Central Statistical Office. The "raw" research sample of IERiGŻ-PIB consisted of 65 large-sized farms in 1995, whereas the number of large entities in 2010 was 131.

Large agricultural holdings operating in the form of private companies have, on average, a much larger AA than farms belonging to natural persons (in 2007 the average AA was 745 ha). Therefore, despite their much smaller number, the share of companies, when considered as a group, in the structure of domestic AA ownership is only 21% lower than that of the most numerous groups of large entities – farm holdings belonging to natural persons. Literature on the subject features mostly studies devoted to farm holdings of natural persons. The legal and organisational form has been coded in a binary form (1 – legal person, 0 – natural person) in a set of independent variables (Table 3). The legal persons more often operate on own land and specialise in field crops. In addition, they demonstrate a greater scale of simplification, specialisation and production concentration.

Our analyses referred to the largest units belonging to the group of large enterprises, with an area of over 100 ha. The basic description is summarised in Tables 4–5.

4. RESULTS AND DISCUSSION

Presenting results of the panel model estimation is preceded by indicating differences in profitability measures (ROS, ROA and ROE).[12] Tables 6–8 present the results for the three econometric models, for three financial indicators (ROS, ROE and ROA), respectively.[13]

[11]The questionnaires contain data on the structure of agricultural land, crop and live-stock production, farm size, location, balance sheet, profit and loss account, and additional information relating to the level and field of education, use of fertilisers, possession limits and quotas, and directions of credit and investment.

[12]In our micro-panel, we use a typical measure of differentiation (dispersion), i.e., the Gini index (coefficient). It should be noted that in the examined panel, the lowest variation concerned sales profitability (for which the Gini index amounted to 0.134) which was described by the lowest variation. However, in the case of ROA and ROE, Gini coefficients were in both cases close to 0.5. The aforesaid calculations with figures as illustrations can be received directly from the authors on request.

[13]Detailed results of joint test on named regressors, test for differing group intercepts, Wald joint test on time dummies, distribution free Wald test for heteroscedasticity, test for normality of residual and Pearson CD test for cross-sectional dependence can be received directly from the authors on request.

Table 3. Description of variables used in the models

Variable name	Unit	Description
ROS (*y*)	%	Return on sales as the ratio of the gross profit (loss) on sales to the sum of the total revenue
ROE (*y*)	%	Return on equity as the ratio of the gross profit (loss) on sales to the equity
ROA (*y*)	%	Return on assets as the the ratio of the gross profit (loss) on sales to the the total assets
Subsidy rate I	%	Ratio of all subsidies to operating revenues
Subsidy rate II	%	Ratio of direct payments to operating revenues
Legal form of organisation	0 or 1	Dummy variable (1 — legal entity, 0 — other forms)
Prefential credits to toal credits ratio	%	Share of preferential credits and loans in a total sum of credits and loans
HHI	(0;1)	Herfindahl-Hirschman index is defined as measure of production concentration. It is calculated by squaring the crops, livestock and other production share in total production of farm, and then summing the resulting numbers
Leased land to agricultural area ratio	%	Share of leased land in the agricultural area
Arable land to agricultural area ratio	%	Share of arable land in the agricultural area
Soil quality index		This measure indicates quality of soil
Equity to borrowed capital ratio	%	Share of equity in borrowed capital
Fixed assets/current assets	%	Share of fixed assets in current assets
Crop revenues/sales revenues	%	Share of crop sales revenues in total sales revenues from agricultural production of farm
Investment rate	%	Gross investment/annual depreciation
Financial stress index	%	Interest and rental fees to sales revenues ratio
Current liquidity		Ratio of current assets to current liabilities
Financial surplus/liabilities	%	Ratio of net financial result (increased by amortisation) to total farm liabilities
Equipment used in support of operation (work)/technical devices	%	Ratio of total fixed assets (gross) to average number of full-time workers
Technical equipment of farmland	%	Ratio of total gross fixed assets to the total area of farmland (hectare)

(continued)

Table 3. Continued

Variable name	Unit	Description
Crop insurance	0 or 1	Dummy variable (1— if a farm buy, 0 — otherwise)
Livestock insurance	0 or 1	Dummy variable (1 — if a farm buy, 0 — otherwise)
Location on Less Favoured Areas (LFA)	0 or 1	Dummy variable (1 — if a farm is located on LFA, 0 — otherwise)
Agro-environmental schemes participation	0 or 1	Dummy variable (1 — if a farm participates, 0 — otherwise)
Rural Development Programme (RDP) participation	0 or 1	Dummy variable (1 — if a farm participates, 0 — otherwise)
Leasing participation	0 or 1	Dummy variable (1 — if a farm uses, 0 — otherwise)
Age of manager	years	
Work experience of the manager	years	
Fertilizer application	Kg per ha	
Education level of the manager	0 or 1	Dummy variable (1 — higher education, 0 — secondary education or below)
Number of managers (full-time employees)		
Livestock units (LU)	LU per 100 ha	
Cereals in sown area	%	The share of cereals in sown area
Location of farm (region)	0 or 1	Dummy variable (one of the 16 regions)
Subsidies	1000 PLN	Direct payments LFA payments Sugar payments Refund of excise Subsidies to seeds 2. Pillar payments Other subsidies Agri-environmental payments Total subsidies

Note: PLN – Polish zloty.
Source: Own compilation.

Table 4. Key characteristics of large farms – descriptive statistics (2007–2011)

Specification	Mean	SD	Median	Min.	Max.
ROS [%]	0.99	0.25	1.00	0.16	2.17
ROA [%]	0.12	0.11	0.09	0.00	0.68
ROE [%]	0.18	0.21	0.14	0.00	2.51
Net profit (loss)	942.61	2,990.21	466.50	0.00	55,326.00
Profit (loss) on sales	−52.26	887.31	−50.00	−6,537.00	4,953.00
Equity	5,732.12	9,761.77	3,305.00	204.00	111,836.00
Total assets	8,693.14	14,508.43	5,018.50	266.00	142,853.00

Source: Authors' calculations.

Table 5. Description of the balanced panel of large farms (average values for key variables)

Variables	2007	2008	2009	2010	2011
ROS	1.54	0.59	0.75	1.12	0.17
ROE	21.40	11.12	13.04	19.51	12.53
ROA	13.73	7.92	7.54	13.41	14.22
Subsidy rate I*	16.17	18.68	23.32	20.21	24.91
Subsidy rate II**	11.81	12.21	16.45	13.95	18.69
Herfindahl-Hirschman index (HHI)	0.44	0.73	0.45	0.76	0.78
Equity to liabilities	9.04	11.85	8.11	5.87	28.63
Investment rate	64.68	53.23	32.82	19.89	127.19
Financial surplus to liabilities	2.54	1.71	1.72	3.02	3.35
Fixed assets to utilised arable area ratio	14.49	16.23	18.03	18.54	11.87
Fixed assets to current assets ratio	8.11	8.16	7.16	7.02	3.54

Note: * Ratio of all subsidies to operating revenues; ** Ratio of direct payments to operating revenues.
Source: Authors' calculations.

As presented in Table 6, the subsidy rate negatively affect return on sales (coefficient −0.012) Moreover, the ratio of financial surplus to liabilities, use of livestock insurance may be considered as stimulants of ROS, given the positive values of their coefficients. Moreover, *P*-value for the livestock insurance (0.044) indicates that this variable is significant at 5% level. According to the results in Table 6, the ratio of fixed assets to current assets (the so-called tangibility) affected ROS negatively. Moreover, the impact of tangibility on ROS was statistically significant at 1% level.

Since our Durbin–Watson statistic (1.690) is higher than dL (1.503) and lower than dU (1.771) the test is inconclusive. Nevertheless, since our $d < 2$, it is not necessary to test for

Table 6. Panel multiple regression results for ROS

Variables	Coeff.	Std. Err.	*t*-stat	Prob >|*t*| > 0
Const.	**1.231**	**0.037**	**33.268**	**0.000**
Subsidy rate (II)	**−0.012**	**0.002**	**−5.409**	**0.000**
Financial surplus to liabilities	**0.010**	**0.003**	**3.239**	**0.001**
Livestock insurance	**0.081**	**0.040**	**2.019**	**0.044**
Fixed assets to current assets	**−0.005**	**0.001**	**−3.237**	**0.001**
2008	**−0.156**	**0.032**	**−4.963**	**0.000**
2009	**−0.142**	**0.033**	**−4.258**	**0.000**
2010	−0.021	0.032	−0.668	0.505
2011	−0.018	0.036	−0.511	0.610
Number of observations	390			
LSDV *R*-squared [%]	58.6			
LSDV *F* (74, 260)	4.979			
Log Likelihood	138.181			
Bayes Information Criterion (BIC)	159.698			
rho1	0.046			
SE of residuals	0.182			
Within *R*-squared [%]	32.2			
Prob > *F*	0.000			
Akaike Information Criterion (AKI)	−126.362			
Hannan – Quinn Criterion (HQC)	−12.318			
Durbin – Watson Stat.	1.690			

Note: Coefficients that are significant at $P < 0.05$ are highlighted in bold.
Source: Own computation.

negative autocorrelation. We analyse the possible presence of the heteroscedasticity. Our panel data after conducting the Wald test for heteroscedasticity indicates that there is no constant variance over time. However, due to heteroscedasticity in the error term we have to use panel corrected standard errors (HAC estimator).[14]

[14]Analysis of the diagnostic test statistics for a first panel model indicates that a joint significance of variables used was detected (*P*-value <0.001). Group intercepts were statistically different. Results from Wald joint test on time dummies (df 4, test statistics 43.895, *P*-value <0.001) indicate that all time dummies may be used in the panel model. Pesaran cross-sectional dependence (CD) test verifies this dependence in small-T, large-N panels. Cross-sectional dependence can lead to a bias in the tests results. The null hypothesis is that residuals are not correlated. We did not detect a cross-sectional dependence (*P*-value 0.695 for CD test).

Table 7. Panel multiple regression results for ROA

Variables	Coeff.	Std. Err.	*t*-stat	Prob >|*t*| > 0
Const.	**0.112**	**0.029**	**3.847**	**0.000**
Crop output/Total output	**0.001**	**0.000**	**2.135**	**0.036**
Subsidy rate II	**−0.004**	**0.002**	**−2.159**	**0.034**
Rented area to total area	<0.001	0.000	0.383	0.703
Financial surplus/Liabilties	**0.006**	**0.002**	**3.314**	**0.001**
RDP subsidy (dummy)	−0.023	0.012	−1.966	0.053
Tangible fixed assets to land area	**<0.001**	**0.000**	**0.624**	**0.534**
2008	−0.059	0.014	−4.348	0.000
2009	**−0.041**	**0.015**	**−2.622**	**0.011**
2010	−0.009	0.014	−0.664	0.508
2011	0.003	0.019	0.159	0.874
Number of observations	390			
LSDV *R*-squared [%]	55.2			
LSDV *F* (74, 260)	3.889			
Log Likelihood	467.672			
Bayes Information Criterion (BIC)	−410.323			
rho1	−0.237			
SE of residuals	0.083			
Within *R*-squared [%]	21.3			
Prob > *F*	0.000			
Akaike Information Criterion (AKI)	−759.344			
Hannan – Quinn Criterion (HQC)	−620.990			
Durbin – Watson Stat.	2.029			

Note: Coefficients that are significant at $P < 0.05$ are highlighted in bold.
Source: Own computations.

Table 7 presents panel regression model exploring ROA. There are some differences (compared to the model with ROS as a dependent variable) in estimation results for models with ROA as a dependent variable. First, according to Table 7, the ratio of crop output to total output was an independent variable that affects ROA slightly positively. This is indicated by the value of coefficient (0.001). The results in Table 7 imply that increasing the ratio of financial surplus to liabilities (coefficient 0.006) may improve ROA. It should be noted that two-time dummies

Table 8. Panel multiple regression results for ROE

Specification	Coeff.	Std. Err.	*t*	Prob >|*t*| > 0
Const.	**0.474**	**0.080**	**5.936**	**0.000**
Sugar subsidy (dummy)	**−0.001**	**0.000**	**−1.997**	**0.047**
Excise tax refund	**0.001**	**0.000**	**3.268**	**0.001**
Fixed assets in lease for current assets	**−0.005**	**0.001**	**−3.396**	**0.001**
Region 8 (Opolskie Voivodeship)	**−0.620**	**0.149**	**−4.151**	**0.000**
Tangible fixed assets/land area	**−0.006**	**0.001**	**−4.325**	**0.000**
Number of observations	390			
LSDV *R*-squared [%]	38.7			
LSDV *F* (84, 305)	2.292			
Log Likelihood	157.980			
Bayes Information Criterion (BIC)	−191.163			
rho1	−0.231			
SE of residuals	0.182			
Within *R*-squared [%]	16,4			
Prob > *F*	0.000			
Akaike Information Criterion (AKI)	−145.960			
Hannan – Quinn Criterion (HQC)	−12.323			
Durbin – Watson Stat.	1.698			

Note: Coefficients that are significant at $P < 0.05$ are highlighted in bold.
Source: Own computation.

(2008 and 2009) were statistically significant but their impact on ROA was negative (similarly as in the previous model for ROS).

Similarly, to the previous model focussing on identifying the determinants of ROS, we present diagnostic test statistics. Since our Durbin-Watson statistic (2.029) is higher than dU (1.77118), there is no statistical evidence that the error terms are positively autocorrelated. Nevertheless, taken $4-d$ ($4-d$) > dU, there is no statistical evidence that the error terms are negatively autocorrelated.[15]

Table 8 refers to the panel regression model exploring ROE. The variable of special interest in this study is agricultural subsidy. The coefficient for one of the dummy variables, namely

[15]Analysis of the diagnostic test statistics for a first panel model indicates that a joint significance of variables used was detected (*P*-value <0.001). Group intercepts were statistically different. Results from Wald joint test on time dummies (df 4.00, test statistics 26.755, *P*-value <0.001) indicate that all time dummies may be used in the panel model. We detected cross-sectional dependence that may lead to a slight bias (*P*-value <0.000 for CD test).

sugar subsidy, was negative at 5% level significance. On the other hand, the coefficient of the next dummy variable related to agricultural policy (excise tax refund for diesel fuel used in agricultural production) was positive and statistically significant at 1% level of significance. The ratio of fixed assets in lease to current assets was significant, but negative. This means that increasing use of the lease/rental (measured by the proxy: fixed assets in lease to current assets) agreements does not improve the level of ROE. Only one regional dummy variable (for Opolskie Voivodeship) was statistically significant, but the impact of location of large-sized agricultural holding in this voivodeship was negative (the value of coefficient is −0.620).

Since our Durbin − Watson statistic (1.698), presented in Table 8, is higher than dL (1.50312) and lower than dU (1.77118) the test is inconclusive. Nevertheless, since our $d < 2$, it is not necessary to test for negative autocorrelation. As shown in *Table 10*, due to heteroscedasticity (detected Wald test for heteroscedasticity $p < 0.001$) in the error term, we have to use panel corrected standard errors (HAC estimator).[16]

Our results indicate a significant negative impact of subsidy rates on profitability indicators. As Rizov et al. (2013: 2) explained, CAP subsidies "may negatively affect farm productivity because they distort the production structure of recipient farms, leading to allocative inefficiency". However, Lososová – Zdeněk (2014) highlighted the link between the type of agricultural production and the share of subsidies to profit, which was the greatest in the Czech agricultural holdings specialised in crop production. Numerous empirical and theoretical studies underline that the impact of decoupled payments depends on farm size. Consequently, exploring this relationship may be crucial from the perspective of financial stability and performance. Similar conclusions (but emphasising the role of farm investment) were formulated by Katchova (2010).

Results of empirical studies (Kulawik 2014) obtained for the Polish family-owned farms (FADN panel for the period of 2005–2012) indicated that subsidy rates (defined differently than those adopted for large agricultural holdings) negatively affected the profitability ratios. Such empirical study found that the increasing amounts of the granted subsidies positively affected the farms' liquidity, solvency, investments and cash resources. This means, e.g., that the financial potential of the examined farms improved slightly, and thus, they were able to consider more ambitious restructuring, adaptation and development strategies.

We detected a significant impact of the time dummy variables (2008 and 2009, respectively). This may be explained by the fact that farm profits strongly depend on conditions of agricultural production. In 2008, market conditions for agricultural production definitely deteriorated compared to 2007 (Seremak-Bulge 2009). It should be noted that 2009 was an extremely unfavourable year, as shown by two types of price relations in agriculture (Kulawik 2012; Seremak-Bulge, 2012). Rapid increases in prices of the means of production were accompanied by a steady decline in prices received by farmers. The strongest decline in prices (almost by 50%) referred to cereals. It should be added that macroeconomic conditions for agricultural production in 2010 and 2011 had improved significantly compared to 2008–2009. Furthermore, the macroeconomic situation (country-level) is affected by impulses from the global economy (the process of globalisation highlights the need for sustainable development). This is consistent with

[16]Analysis of diagnostic test statistics for this panel model indicates that a joint significance of variables used was detected (P-value <0.001). Group intercepts were statistically different.

the results from empirical studies of Zakova Kroupova (2016), who found that changes in "output price, mark-up component and technical change" affected the development of profitability of the Czech dairy farms significantly. While Machek – Špička (2014) detected the impact of the economic crisis on the performance of the agricultural sector (as a drop of performance in 2008/09), they did not find a statistically significant correlation between the development of the economy and performance indicators (including those related to profitability) for the period from 2007 to 2012. Unfortunately, they based their research on a limited time series and business-level data from commercial databases.

Our findings may be discussed with reference to the empirical studies of Gloy – LaDue (2003), who built linear regression models for a sample of dairy farms in order to explore the relationship between profitability (ROA as a proxy) and "the adaptation of financial management practices". They found that farm size (described by the variable "herd size") was a significant determinant of ROA (at the 0.10 level). The role of farm size and the type of agricultural production are other aspects in this respect. Némethová et al. (2011) found that the size of agricultural enterprises affected the probability of success and economic/financial stability.

Crop output/total output (as proxy for type of production – crop, mixed or livestock) was a significant determinant of ROA (coefficient 0.001, P-value<0.05). This is partially consistent with the results from annual analysis of financial condition of the Polish farm households (FADN database): the highest rate of return on assets was typical for "horticulture" and "fieldcrops" (Kulawik 2014). Furthermore, Kagan – Kulawik (2013) underlined that crop large agricultural holdings benefited from very high soil quality index and area-based CAP payments. Nevertheless, their rate of ROS was not significant, compared to other type of farms (livestock or mixed farms), because of low efficiency of market transactions.

Our results did not indicate that particular attention should be paid to the variables related to the farm operator. This may result from the process of the sample selection. Probably, the results of the estimation of models employing large research samples, e.g. FADN, would note the significance of qualitative variables related to farm operators. However, Viira et al. (2013) found that larger farms were characterised by a higher level of probability of remaining in business. Moreover, Tóth (2011) underlined the significance of managers of larger farms utilising tax management techniques. Gloy – LaDue (2003) found that the surveyed farm operators, who declared the use of more advanced farm management techniques, were significantly more profitable than those who did not base on any financial calculations. Trnková – Malá (2012) underlined the importance of the skills of managers, finding that, though the largest agricultural enterprises benefited from economies of scale, this did not in itself lead to a significant increase in profits. The Czech economists stated that the disparity in economic results resulted mainly from the skills of managers. This may be exemplified by the case study of the implementation of a new business model for an admittedly small farm in the Czech Republic pay attention at the letter á (Poláková et al. 2015). Reported changes in financial performance (assessed by ROS, ROE and ROA) for the period from 2006 to 2012 may indicate the significant role of techniques of strategic management as stimuli for improved profitability.

Our model describing ROE of large-sized agricultural holdings may be compared to results of Anarfi – Danquah (2017: 43–49) who examined "factors that determines ROE in the Czech Agric and Forest industry" (a panel of 366 firms). They found that profit affected ROE positively. They explained that this indicator can be improved by employing more cost-efficient strategies and increasing the level of sales. For the Polish agricultural sector, possibilities of using

more cost-efficient strategies are rather limited. Similarly as Anarfi – Danquah (2017: 43–49), we found that some indicators related to debt (financial surplus/liabilities) did not have any impact on ROE.

Our findings referring to the significance of variables with rented land shed light on the role of land management, including rental and lease agreements and arrangements, in shaping profitability of large farms (compared to small-scale family-owned farms). We detected significance of ratios that base on rented farm area. Kagan – Ziętara (2017) pay attention at the letters found that farms run by lessees were described by higher Return on Equity and Value Creation Index. Differences were not statistically confirmed, which meant that they were not significant. However, farms basing on own land benefited from a higher level of financial security, expressed by higher values of liquidity ratios (current and quick) and cash flow-to-debt ratio.

The relatively low level of ROE in agriculture results from operational efficiency, determined by low profitability of sales and slow rate of capital turnover, which is further reduced by the lack of the beneficial impact of financial leverage and avoidance of external financing. This is partially consistent with our results for large farms.

5. CONCLUSIONS AND RECOMMENDATIONS

Our empirical study identified the determinants of profitability (measured by ROS, ROA and ROE, respectively) of large Polish agricultural holdings. In-depth analysis sheds light on character of these entities, compared to the Czech Republic and Slovakia.

We formulated the following conclusions:

1. CAP subsidies negatively affect profitability of the Polish large farms. Taken some limitation related to our research sample, the negative dependence may result from distortion of the production structure of the aforementioned entities. Additionally, the use of CAP subsidies involved the adoption of many administrative requirements that could adversely affect cost relations.
2. Crop farming was detected as a significant determinant of profitability of assets. Our results were partially consistent with FADN database, the highest rate of return on assets was typical for "horticulture" and "fieldcrops" farm households. Additionally, speciality in crop farming is connected with a strong degree of linking the farm with the agricultural markets.
3. Characteristics of farm managers did not have any significant impact on farm profitability.

Our results did not indicate that particular attention should be paid to the variables related to the farm operator. This may result from the process of the sample selection, i.e. relatively limited number of entities compared to the Polish FADN that consists of commodity-oriented farms. Nevertheless, the significance of managerial skills for long-term development of agricultural holdings seems to be still important (e.g., Viira et al. 2013; Tóth 2011; Gloy – LaDue 2003). Future qualitative analyses (for example, in-depth interviews or case studies) would indicate more interesting mechanism. In-depth analysis of control variables sheds light on the role of land management, and, in particular, rental/lease agreements. The obtained benefits are related, firstly, to the reduction of equity capital and, secondly, to a more flexible financing system suited to the production cycle.

Our approach goes beyond the traditional schemes (for example, the well-known Du Pont models). The FEM model is used when the units in the panel are different due to the hidden factors that are not included in the explanatory variables or cannot be accurately controlled. We dealt with the aforesaid situation, although a quality of obtained models is not very good. Diagnostics of the model indicated the advantage of the models with fixed effects (FE) over the models with random effects (RE). That was also confirmed by model verification and testing.

We make recommendations for agricultural policy development. The subsidy policies within CAP 2020+ should be very sensitive (by means of instruments of capping and degressiveness) to large-sized agricultural holdings that are competitive market players in the selected countries of the EU. The case of Poland indicates their increasing role as producers of agricultural products. Policymakers should design regulations related to land use policy, taking into consideration the differences in the objectives of large farms compared to small family farms. Farmland rental agreements in Poland are affected by some institutional and legislative barriers.

Some managerial implications also come out of our research. Current monitoring ratios of tangible fixed assets to land area seems to be of great importance for farm financial management. This strongly relates to the decisions related to depreciation, rental and lease agreements. Risk management tools (in particular, livestock insurance) as significant determinants should be taken into consideration for covering the losses related to production risk. Farm managers should be engaged in increasing the ratio of financial surplus to liabilities. From the perspective of implementation of financial instruments in CAP 2020+, a nexus between profitability and financial gearing should be monitored in a very detailed way (including controlling systems, Balanced Scorecard or Du Pont model).

There are some limitations related to our research. First, the research sample was deliberately chosen and limited number of large farms was associated with using research panel. Second, the lack of qualitative variables related to farm-level management (including, the applied farm management techniques) and controlling tools may be treated as an important limitation of our empirical studies.

In future research particular attention should be paid to more detailed analysis of farm profitability in relation to sustainable growth that links ROS (dynamics of sales) and ROE (capital structure). Moreover, further detailed analysis of farm profitability in connection with sustainable growth is also needed in connection with a balance between increased sales at farm level and increase in equity. This concept links monitoring ROS and ROA, because balanced growth is affected not only by asset productivity, but also by leverage decisions.

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