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Investment behavior of the Polish farms – is there any evidence for the necessity of policy changes?

Zachowanie inwestycyjne polskich rolników – czy konieczna jest zmiana polityki rolnej?

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ABSTRACT

Investment in agriculture is related to modernization and technological upgrading of agricultural holdings and it influences all the aspects of functioning of farms. Numerous studies proof that investment plays a key role in improving farms' competitiveness and increases their resilience to changes in surrounding. The aim of the paper is to analyze the investment behavior of the Polish farmers. The study was conducted on the basis of the Polish Farm Accountancy Data Network data for the period 2009-2015 and it applies a logistic regression model. The results indicate that eight variables have a statistically significant impact on investment. These are: share of the land leased by the farmer under a lease contract for a period of at least 1 year in the total agricultural land, land yield indicator, land productivity index, education of the person managing the farm, quality of utilized agricultural area, production type, debt capital ratio and return on equity. Following the results, it can be stated that policy support needs to concentrate on smaller farms which lack resources to conduct investment necessary for the improvement of their competitiveness.

Keywords: farm types, investment behavior, logit model

ABSTRAKT

Inwestycje w rolnictwie są związane z modernizacją i unowocześnieniem technologicznym gospodarstw rolnych i mają wpływ na wszystkie aspekty ich funkcjonowania. Liczne badania potwierdzają, że inwestycje odgrywają kluczową rolę w poprawie konkurencyjności gospodarstw rolnych i zwiększają ich odporność na zmiany w otoczeniu. Celem artykułu jest analiza zachowań inwestycyjnych polskich rolników. Badanie przeprowadzono na podstawie danych Polskiego Systemu Zbierania i Wykorzystywania Danych Rachunkowych z Gospodarstw Rolnych za okres 2009-2015 z wykorzystaniem modelu regresji logistycznej. Wyniki wskazują na to, że osiem zmiennych ma statystycznie istotny wpływ na inwestycje. Są to: udział gruntów wydzierżawionych przez rolnika na podstawie umowy dzierżawy na okres co najmniej 1 roku w całkowitej powierzchni gruntów rolnych, wskaźnik dochodowości ziemi, wskaźnik produktywności ziemi, wykształcenie osoby zarządzającej gospodarstwem, jakość użytków rolnych, rodzaj produkcji, wskaźnik zadłużenia aktywów ogółem i wskaźnik rentowności kapitałów własnych. W oparciu o uzyskane wyniki możemy stwierdzić, że wsparcie publiczne powinno koncentrować się na mniejszych gospodarstwach, którym brakuje zasobów, aby przeprowadzić inwestycje potrzebne do poprawy ich konkurencyjności.

Kluczowe słowa: model logitowy, typy gospodarstw rolnych, zachowania inwestycyjne

INTRODUCTION

Investment in agriculture is related to modernisation and technological upgrading of agricultural holdings and it influences all the aspects of functioning of farms. Numerous resources proof that investment plays a key role in improving farms' competitiveness and increases their resilience to changes in surrounding (price volatility, policy reforms or climate changes). Moreover, investment improves efficiency of agricultural production and rises farm incomes. It is also a driving force for sustainable development, poverty reduction and ensuring world food security (Sckokai and Moro, 2005; Olsen and Lund, 2009; Viaggi et al., 2011; Mozumdar, 2012; Sandbichler et al., 2013; Syed and Miyazako, 2013; Hurankova et al., 2015; Femenia et al., 2017; Stavytskyy and Prokopenko, 2017). Therefore, in recent years the support for investment within the common agricultural policy has gained importance. Investment support measures provide funding for investment to increase productivity within the agricultural and forest sector and to diversify production into non-agricultural activities. Furthermore, related infrastructure investment for the agricultural and forest sector and non-remunerative investments supporting agri-environmental schemes are available. The target groups are economic entities (farm and forestry holdings; micro, small and medium sized enterprises in sectors processing agricultural and forest products) within the agricultural and forest sector as well as individuals trying to diversify and establish businesses or services outside the agricultural sector.

Investment decisions undertaken by farmers are determined by a number of different factors, which can be divided into economic and non-economic ones. The later factors are represented by a) farmer demographic characteristics, such as age, gender, education, social status, farming experience or knowledge; b) farmer attitudes and opinions, such as the level of risk aversion, membership in organizations, political opinion, main source of information, or environmental preferences; and c) agronomic characteristics, such as soil fertility and degree of soil erosion, or animal welfare practices. Economic factors include a) farm management aspectss such as input-use intensity, the ratio between family and hired labour, farm size, production costs, crop diversity, gross farm income, off-farm activities, debt level, access to credit, use of extension and technical services, farm productivity and efficiency; and b) exogenous factors like the market size, policy support, input and output prices, interest rates and price variation (Kallas et al., 2012).

The issue of farmers' investment behavior has been a subject of numerous research studies (Featherstone and Goodwin, 1993; Nwibo and Alimba, 2013; Lefebvre et al., 2014; Grzelak, 2015; Kusz and Gędek, 2015; Ayamaga et al., 2016; Levi et al., 2017; Ferto et al., 2017;). The need for conducting studies concerning the range, scale and factors determining investment decisions stems from a gaining in importance debate on their impact on the process of adaptation of agriculture to the changes in its surrounding. Moreover, knowledge of the factors determining farmers' investment decisions has a significant meaning in the assessment of the legitimacy and the value for money of measures aimed at promoting and supporting investment activities with the use of public funds. Given this context, the aim of the paper is to analyze the investment behavior of the Polish farmers. This includes answering the following research questions: What types of the Polish farms invest? What is the scale of their investments? And how do socio-economic factors affect the likelihood of investment in fixed assets?

The results obtained can have implications for policy makers, farmers and other stakeholders interested in increasing agricultural investment. The paper is part of the debate on better understanding the determinants and rationale for farmers' investment decisions. The knowledge of them can have substantial impact on designing and implementing effective support measures for investment in agricultural holdings and can enable policy makers to forecast farmers' reactions to possible changes in rural development policy.

MATERIALS AND METHODS

The study was conducted on the basis of data obtained from agricultural holdings conducting agricultural accounting for the needs of the Polish Farm Accountancy Data Network. The study included two stages. In the first stage of the research, the scale and dynamics of changes in the investment activity of agricultural holdings was characterized by the type of production, the economic size of the agricultural holding and the size of agricultural land. This stage covered the years 2009-2015. In the second stage, the probability of investment in fixed assets in farms was examined. For the analysis, data from 2015 was used, which included a sample of 12,072 farms. In order to extract a set of variables that are predicts of the variable *Y* - investments in fixed assets, a logistic regression model was used to investigate the influence of several independent variables X_1, ... , X_k on the dependent variable *Y*. Because the explained variable is of a dichotomous nature allowing logit model was applied (Hosmer and Lemenshow, 2000; Kleinbaum and Klein, 2002):

$$P(Y=1/X_1,...,X_k)=\frac{e^{\alpha_0+\alpha_1X_1+...+\alpha_kX_k}}{1+e^{\alpha_0+\alpha_1X_1+...+\alpha_kX_k}}$$

where:

Y – dependent variable equal 1 when the given event occurs and 0 when the event does not take place,

α_0, α_1, ..., α_k – model parameters,

X_1, ..., X_k – independent variables either quantitative or qualitative.

By using logarithming, the logistic model was transformed into a linear model. For this purpose, the concept of odds ratio was introduced, that shows the ratio of the probability of occurrence of a specific event to the probability that this case will not occur, i.e.:

$$\frac{P(Y=1/X_1,...,X_k)}{1-P(Y=1/X_1,...,X_k)}=\frac{e^{\alpha_0+\alpha_1X_1+...+\alpha_kX_k}}{1+e^{\alpha_0+\alpha_1X_1+...+\alpha_kX_k}}:\frac{1}{1+e^{\alpha_0+\alpha_1X_1+...+\alpha_kX_k}}=e^{\alpha_0+\alpha_1X_1+...+\alpha_kX_k}$$

After estimating logistic regression model parameters, the theoretical values of the Y variable were determined. The assessment of the degree of fit of the logistic regression model to the empirical data was carried out using the final measure, which takes values from the interval (Maddala, 2001):

$$R^2_{zlicz}=\frac{n_{11}+n_{22}}{n_{11}+n_{12}+n_{21}+n_{22}}$$

The quality of the logistic regression model was also assessed using the ROC curve (Receiver Operating Characteristic Curve) (Sompolska-Rzechuła and Świtłyk, 2016).

The variables adopted in the model were quantitative and qualitative. The choice of variables was based on the analysis of the current research on the implementation of investments in agriculture and the analysis of correlations between variables. To assess the likelihood of investment in fixed assets, the following set of potential features was adopted: X_1 - size of agricultural land (ha); X_2 - share of the land leased by the farmer under a lease contract for a period of at least 1 year in the total agricultural land (%); X_3 - share of arable land in the total agricultural land (%); X_4 - land yield indicator (PLN/ha); X_5 - land productivity index (PLN/ha); X_6 - production type (1 - plant or animal specialization, 2-mixed); X_7 - labor input (AWU); X_8 - own labor input (FWU); X_9 - education of the person managing the farm (1 - elementary education, 2 - non-agricultural basic vocational education, 3 - agricultural basic vocational education, 4 - non-agricultural secondary education, 5 - agricultural secondary education, 6 - non-agricultural tertiary education, 7 - agricultural tertiary education); X_{10} - age of the farm manager (in years); X_{11} - amount of direct payments received (PLN); X_{12} – amount of investment subsidies received (PLN); X_{13} - quality of utilized agricultural area (soil bonitation index); X_{14} - total liabilities of the agricultural holding (PLN); X_{15} - total assets debt ratio (%); X_{16} - debt capital ratio (%); X_{17} - profitability ratio of total assets (%); X_{18} - return on equity (%); X_{19} - economic size of an agricultural holding (PLN); X_{20} - total costs (PLN).

In order to find the best combination of features significantly affecting the likelihood of investment in fixed assets on an agricultural holding, formal selection was made by means of stepwise backward regression.

RESULTS AND DISCUSSION

Investment activity in agricultural holdings in Poland

The analysis of farms realizing investments in fixed assets due to the type of production showed that a significant percentage of farms carrying out investments were farms of mixed production type (average of 40.80%). A high percentage of farms carrying out investments in fixed assets were also farms specializing in field crops (20.56%) and dairy farms (on average 24.03%) (Figure 1). The smallest share of investing companies was observed among horticulture farms (average 1.85%). In the analyzed period, the percentage of agricultural holdings carrying out investments decreased from 84.40% to 83.91%. Mixed farms were the ones which the most limited the investments (a decrease of 8.53 pp). Slight decreases in the percentage of agricultural holdings carrying out investments were recorded in horticulture farms (-0.76 pp), other permanent crops (-0.17 pp) and granivores (-0.96 pp). On the other hand, in the milk, field crop and other grazing livestock farms, the percentage of agricultural holdings carrying out investments increased by 4.57 pp, 3.41 pp and 2.44 pp increased respectively.

Investments in fixed assets in 2009-2015 were carried out mainly by small, medium-small and medium-large farms, whose economic size expressed in EUR does not exceed EUR 50.000. Investments were made on average in every third small farm and in every fourth medium-small and medium-large farm. The economically strongest farms – very large (€≥100 000) and, at the same time, the economically weakest – very small (2000≤€<8 000) had the lowest share in the number of farms undertaking investments in fixed assets. In 2015, as compared to 2009, the investment activity was largely limited to small farms (8000≤€<25 000). In this economic group, the percentage of investing farms decreased by 3.19 pp. To a small extent, the investment activity was limited among very large farms (- 0.16 pp), very small (-0.28 pp) and medium small (-0.35 pp). On the other hand, the percentage of investing farms among medium-sized and large farms increased by 2.62 pp and 1.36 pp, respectively.

Large variation among farms investing in fixed assets is also visible in the area of agricultural land. The highest percentage of farms investing in fixed assets was recorded in the group of medium-sized farms (10<20 ha) (average 28.49%). The share of investing farms was observed in

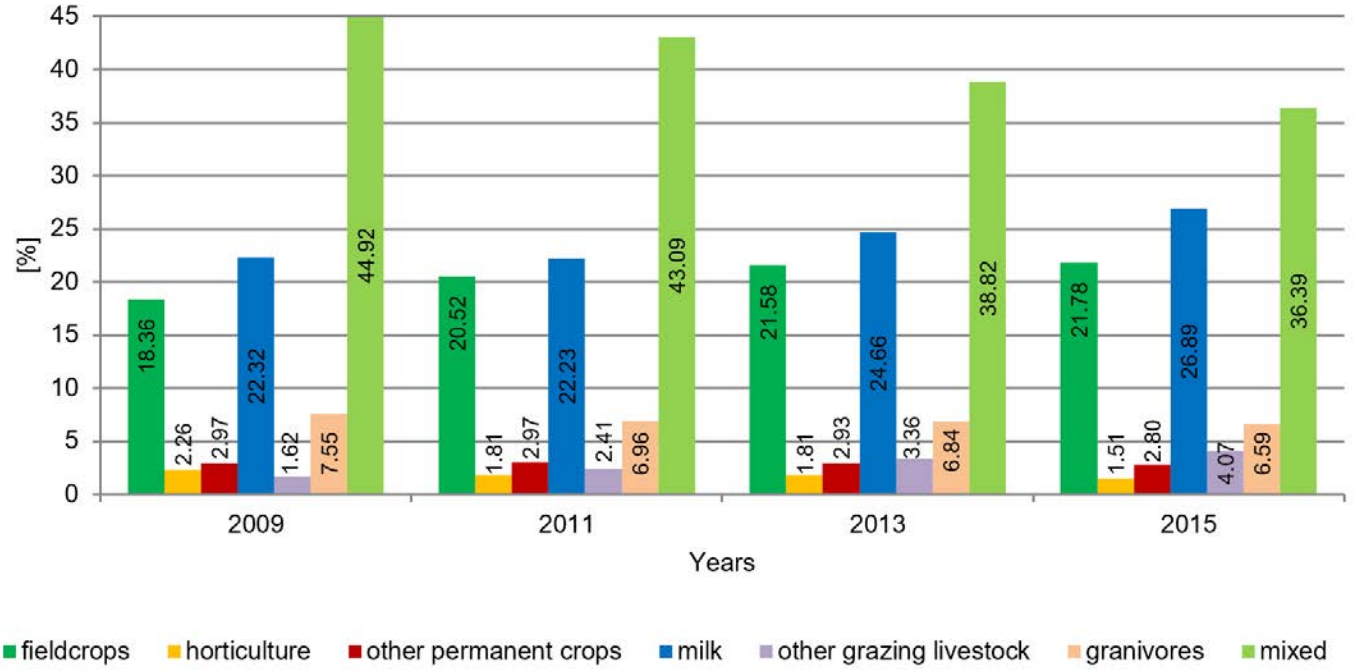

Figure 1. Percentage of agricultural holdings carrying out investment in Poland in 2009-2015, by production type

the group of the very small farms – with less than 5 ha of agricultural land (2.07%). In the analyzed period, the investment activity was slowed down in particular by agricultural holdings with an area of 5 to 10 ha (3.19 pp). The drop in the percentage of investing farms was also seen in the group of very small farms (1.22 pp) and medium small farms (1.79 pp). The percentage of farms investing in fixed assets in the case of farms with over 20 ha of arable land increased. The largest increase in the percentage of investing farms was observed in the group of large farms (2.72 pp) and very large (2.53 pp). A slight increase in the percentage of investing farms was recorded in farms with an area of 20 to 30 ha of arable land (0.95 pp).

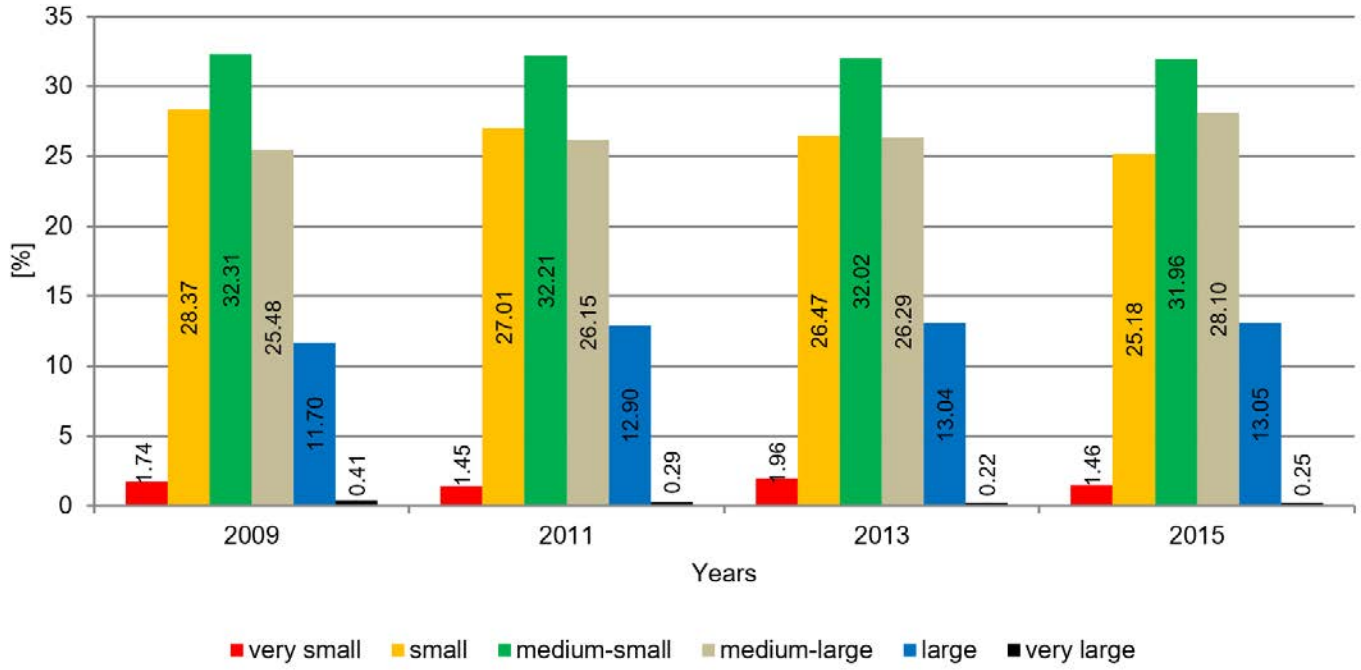

Figure 2. Percentage of agricultural holdings carrying out investments in Poland in 2009-2015, by economic size [ES6]

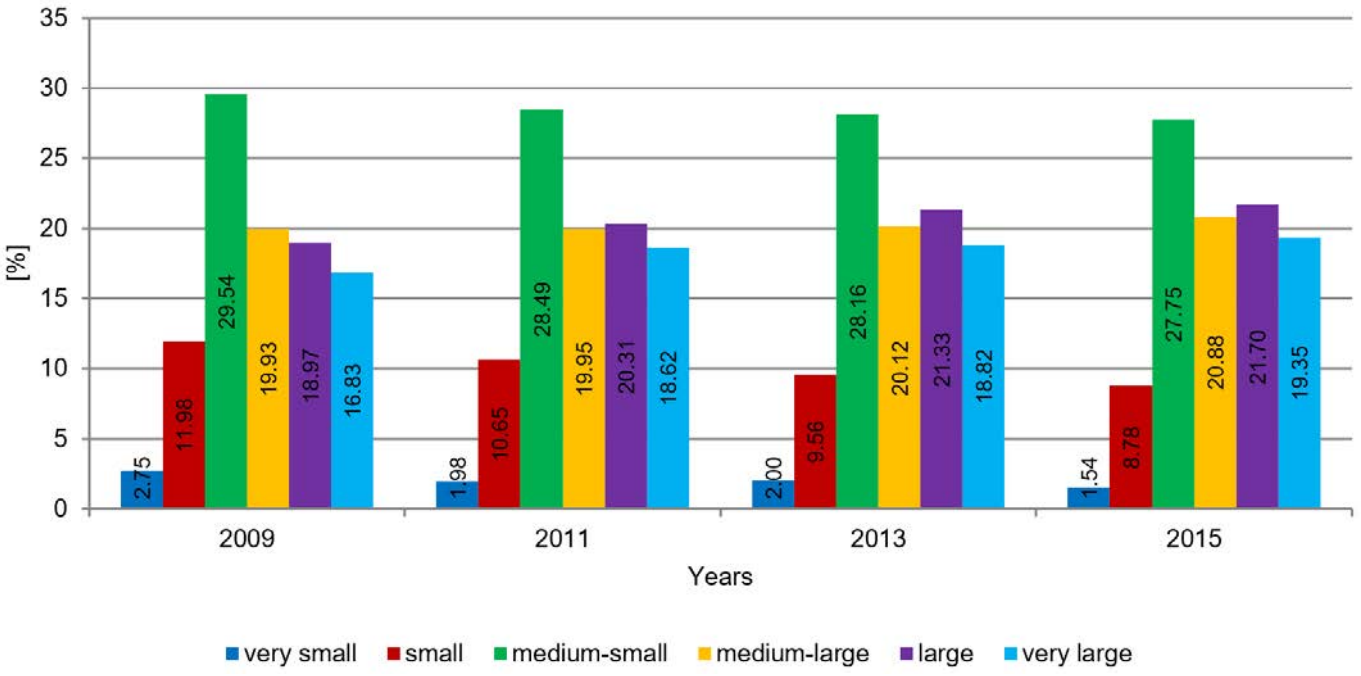

Figure 3. Percentage of agricultural holdings carrying out investments in Poland in 2009-2015, by size of agricultural land [UAA6]

In 2009-2015, agricultural holdings in Poland showed an increase in the average value of investments in fixed assets. The average farm in Poland managed investments amounting to PLN 35,311 to PLN 49,155. In the studied period, the maximum value of investment in fixed assets increased from PLN 6.33 million to PLN 7.23 million (Table 1). In 2009, more than half of farms implemented investments worth approximately PLN 4,000, while in 2015 in the majority of farms the value of investments amounted to over PLN 5,000.

Logit model of the probability of investment in farms

The analysis of the results of the estimation of the parameters of the probability model for investment in fixed assets in agricultural holdings in Poland indicates the statistical significance of the eight variables (X_2 - share of the land leased by the farmer under a lease contract for a period of at least 1 year in the total agricultural land; X_4 - land yield indicator; X_5 - land productivity index, X_6 - production type, X8 - education of farm management, X_{13} - quality of utilized agricultural area; X_{16} - debt capital ratio; X_{18} - return on equity (Table 2). The obtained variables are poorly correlated with each other and at the same time strongly correlated with other variables eliminated from the initial set of variables.

The positive, statistically significant impact on the dependent variable is the share of the leased land, land profitability index, production type, debt capital and

Table 1. Value of investments in fixed assets in agricultural holdings in Poland in 2009-2015 (in '000 PLN)

Years	Median	Maximum	Range	Skewness	Value of investment per farm
2009	4.10	6,335.20	6,968.88	16.12	35,312.55
2011	5.31	5,354.50	6,151.01	11.21	47,313.03
2013	7.49	6,048.79	7,790.39	8.95	62,974.75
2015	5.16	7,235.26	10,316.69	10.17	49,153.10

Table 2. Results of the estimation of the model parameters of the probability of investment in fixed assets in agricultural holdings

Variable	Name of variable	Parameter assessment	p-value	Odds ratio
	Intercept	1.086643	-	-
X_2	Share of the land leased by the farmer under a lease contract for a period of at least 1 year in the total agricultural land	0.008124	0.000001	1.008157
X_4	Land yield indicator	0.000005	0.008062	0.000005
X_5	Land productivity index	-0.000003	0.000002	0.999997
X_6	Production type	1.295444	0.000001	3.652918
X_9	Education of the person managing the farm	-0.102444	0.000001	0.902629
X_{13}	Quality of utilized agricultural area	-0.955697	0.000001	0.384544
X_{16}	Debt capital ratio	0.009868	0.000001	1.009917
X_{18}	Return on equity	0.009146	0.003984	1.009188

profitability ratios. This means that the increase in the size of these variables increases the likelihood of investment in fixed assets on farms in Poland. Other variables applied in the model (land productivity index, education of the person managing the farm, quality of utilized agricultural area) have a negative, statistically significant impact on the dependent variable.

Evaluation of the correctness of the estimated model, counting the accuracy of the classification of farms on the basis of the one set out in Table 3.

The model is characterized by very high sensitivity, which indicates a very high ability to indicate farms realizing investments.

The accuracy of the classification was assessed using the coefficient and the ROC curve. The coefficient assumes the value of 84.14% and it is greater than 50%, so it can be concluded that the classification based on the model is better than random. Figure 4 shows the ROC curve for the estimated model. The area under the ROC curve is 0.70 and is significantly greater than 0.5 (for P>0,000001).

The model is characterized by very high sensitivity and very poor specificity. Very high sensitivity indicates a very high ability of the model to recognize farms characterized by the ability to make investments.

Table 3. Accuracy of the logit model's classification

Qualification of farms based on the logit model	Real farm classification		Overall accuracy of the classification
	$y_i = 1$	$y_i = 0$	
$\tilde{Y}_i = 1$	10,134	1,904	
$\tilde{Y}_i = 0$	11	23	84.14%
Sensitivity, specificity	99.89%	1.19%	

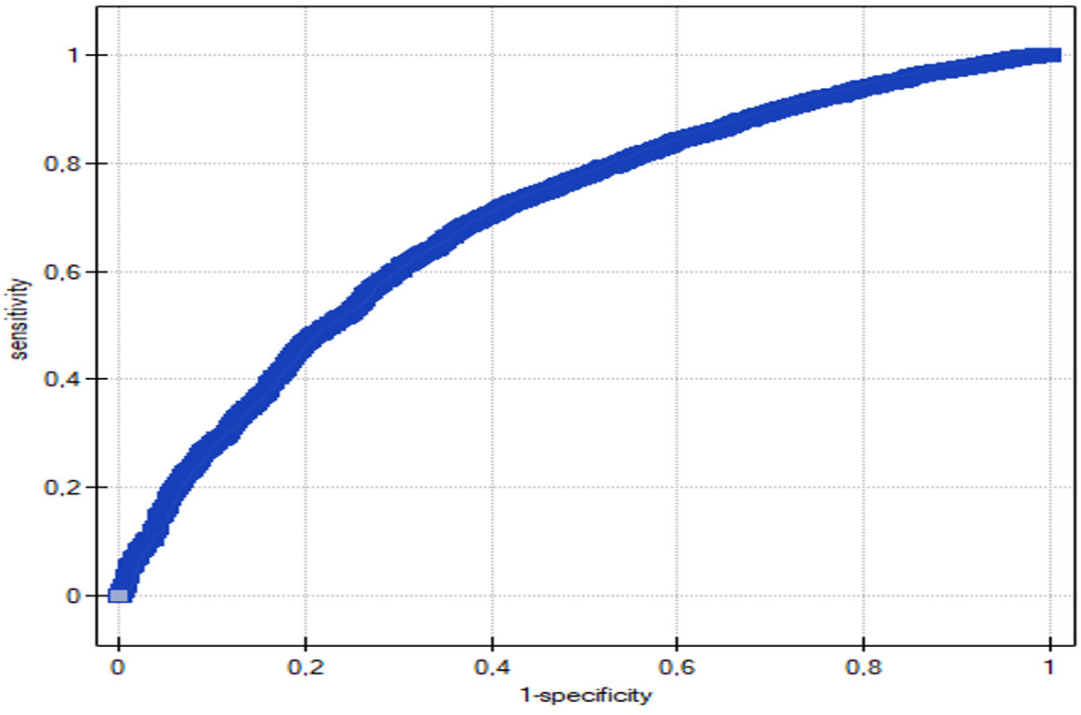

Figure 4. ROC curve

Analyzing the results presented in Table 2, it can be stated that the most significant variables for the implementation of investments in agricultural holdings were: X_2, X_6, X_9, X_{13}, X_{16} and X_{18}. Taking into account the form of the estimated model and interpreting the odds ratios at the i-th variable (assuming that the remaining variables included in the model remain unchanged), the following information is obtained: increasing the share of land leased by the farmer under the lease for a period of at least 1 year in the area of arable land by one percent, increases the chances of investment in fixed assets in farms by 8%. Lease of land is associated with an increase in the scale of production, and thus makes it necessary to increase or modernize fixed assets used on the farm. This is in line with the results of the research of Hou and others (2017), who indicated that the larger area of land and the larger area of leased land have a significant impact on investments in agricultural holdings. On the one hand, a larger area leads to higher income or capital flow, which creates opportunities for investment in fixed assets; on the other hand, increasing the area by renting land sometimes requires investment. Zahonogo (2016) also proves that there is a connection between land rights and investment decisions of farmers. This author emphasizes, however, that the possibility of renting land stimulates short-term investment decisions of farmers, while significantly limiting long-term investment decisions.

Another factor significantly affecting the increase in the likelihood of investing in fixed assets is the type of production. The results of the conducted research indicate that the change in the type of production from the specialization to mixed production will increase the investment opportunities in fixed assets by 265%. This is due to the fact that in mixed farms there must be a fixed amount of fixed assets serving directly or indirectly existing production branches in it, such as machinery and equipment, farm buildings, drainage devices, etc. Therefore, more investments are implemented in them.

A similar impact on increasing the chances of investment in an agricultural holding has: the debt ratio of equity and profitability ratios of equity. Increasing the value of these indicators by one percent contributes to the increase of the investment potential in fixed assets on the farm by 1%. Therefore, an increase in the financial leverage, i.e. involvement of external capital, raises farmers' investment likelihood. Kochar (1997) based on the results of the conducted research indicates that access to credits and loans from any source is helpful in reducing the low level of fixed assets, improving infrastructure and development. In addition, the increase in return on equity reflect high sales profitability, high asset turnover and a relatively high degree of leverage effect, which directly affect the financial position of the agricultural holdings. Thus, the increase in management efficiency increases the chances for investments in fixed assets in farms.

Increase in the educational level of a person managing a farm by one category, results in a reduction of the likelihood of investing in fixed assets by 9%. The Kwanmuang (2014) study showed similar results. The negative impact of an increased level of education on the implementation of investment on an agricultural farm is probably due to the non-agricultural work undertaken by these people, which discourages investment into an agricultural holding.

A negative, statistically significant impact on the implementation of investments in fixed assets had the soil bonitation index. If it increases by one unit, the chance for investment in farms will decrease by 61%. Farms with inferior, less fertile soils require greater investment in equipment and devices for soil preparation for specific crops. Soils of poor quality require much larger agrotechnical, agrochemical and drainage treatments.

CONCLUSIONS

This study presents the investment behavior of agricultural holdings in Poland and presents a logistic regression model that made it possible to determine the factors affecting the probability of investment in farms. The results indicate that in Poland in 2009-2015 over 80% of farms invested in fixed assets. In 2015, compared to 2009, the percentage of investing farms slightly decreased. On the other hand, the average value of

investments increased. Most investments were made by mixed and dairy farms. Investment activity was mainly the domain of economically strong farms with a large area of arable land (over 20 ha). The results of the model indicate that eight variables have a statistically significant impact on the implementation of investment in agricultural holdings, of which six were the most important for the implementation of the investment. These are: share of the land leased by the farmer under a lease contract for a period of at least 1 year in the total agricultural land, land yield indicator, land productivity index, education of the person managing the farm, quality of utilized agricultural area, production type, debt capital ratio and return on equity. It was found that an important positive impact on the implementation of investment in agricultural holdings is exerted by the increase in the area of leased lands. Also, the probability of investment realization grows with the increase in the return on equity and the debt ratio of equity. Thus, the possibility of using the financial leverage in a larger way determines the investment decisions of farmers. The likelihood of investment implementation is also increased in the case of a greater diversification of agricultural production. In turn, the education of the farm management and the quality of the soils had a significant negative impact on the probability of investment in agricultural holdings.

The obtained research results allow providing implications for policy instruments that should support the implementation of investments in smaller and economically weaker farms. Agricultural policy should also focus on increasing farmers' access to external sources of financing. This will enable farmers to modernize or purchase fixed assets necessary to expand or diversify their activities. It is also important to properly shape legal provisions concerning the trade in property rights, both sales, which results in the transfer of ownership rights and the lease, which results in the acquisition of a dependent ownership title resulting from the contract.

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