ECONOMICS
& Sociology

Namiotko, V., Galnaitytė, A., Baležentis, T., & Wang, P. (2019). The impact of investment support on labour productivity in Lithuanian family farms: A propensity score matching approach. *Economics and Sociology*, *12*(1), 342-352. doi:10.14254/2071-789X.2019/12-1/21

THE IMPACT OF INVESTMENT SUPPORT ON LABOUR PRODUCTIVITY IN LITHUANIAN FAMILY FARMS: A PROPENSITY SCORE MATCHING APPROACH

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ABSTRACT. The aim of this paper is to assess the impact of investment support on labour productivity in Lithuanian family farms. This issue is of particular importance when appraising whether the investment support has had the anticipated effects. Propensity score matching is employed to quantify the average treatment effect on the treated farms. The research is based on panel data from the Farm Accountancy Data Network covering the period of 2007–2012. The results show that Lithuanian farmers' participation in investment measures did not result in labour productivity gains. These results provide guidance for policy makers with regards to decisions on investment support measures beyond 2020.

Received: October, 2018
1st Revision: December, 2018
Accepted: March, 2019

DOI: 10.14254/2071-789X.2019/12-1/21

JEL Classification: C21, Q12, Q18

Keywords: investment support, labour productivity, Lithuania, family farms, propensity score matching.

Introduction

Investment support aimed at increasing farms' productivity is one of the most important measures within the European Union (EU) Member States' rural development programmes (Ciaian *et al.,* 2015). The effects of investment support, therefore, have attracted considerable academic interest in recent years. For instance, Buysse *et al.* (2011), after analyzing the effects of different kinds of support measures, concluded that investment support contributed to output and therefore to income growth in Belgian agriculture. Kollár and Sojková (2016) revealed that investment subsidies significantly affected the efficiency of farms in Slovakia. Pechrova (2012) showed that investment support helped Czech farmers to adopt new technologies and innovations.

A closer look at the literature on the effects of investment support, however, reveals that such support along with positive effects causes a variety of negative processes. Ciaian *et al.* (2015) found that investment support resulted in growth of prices for the resources used in farm production. Veveris (2014) and Ratinger *et al.* (2015) observed that such support also widened the gap between small and large farms – in most cases investment support was used by large farms, while small farms did not participate in investment measures due to complicated administrative procedures, co-financing requirements, lack of entrepreneurship skills etc. Wigier *et al.* and Papageorgiou (2015) showed that investment subsidies very often stimulated excessive investment.

When analyzing scientific literature on the impact of investment support on labour productivity, it can be seen that previous studies do not provide a clear, unambiguous answer to this question, and some even contradict each other. Hlavsa *et al.* (2017) evaluated investment activities of farms in the Czech Less Favoured Areas (LFAs), as compared to those in non-LFAs. They demonstrated that farms receiving investment subsidies had higher labour productivity than unsubsidized farms. Similarly, Medonos *et al.* (2012) and Ratinger *et al.* (2013) found that investment support measures improved labour productivity in Czech Republic, however, this effect varied significantly between different farm types, farming conditions and farm sizes. Moreover, in another study, Ratinger *et al.* (2018) demonstrated that the impact of investment support on labour productivity was positive only in the period of 2008-2011.

Takács (2014) examined changes in labour productivity in Hungary and Poland in the context of all other EU member states. He found that, during the research period, labour productivity in Hungarian farms increased, while at the same time Hungarian farms' investment lagged behind farms' investment in the old EU Member States. On the other hand, Polish farms' investment were higher than in the EU-15 countries, while labour productivity was still far behind the leading EU member states. However, Pawłowska *et al.* (2018) showed that in recent years labour productivity in Polish farms increased due to investment support.

Kirschweger *et al.* (2015), after analyzing the impact of investment support on economic performance of Austrian farms, concluded there was a positive effect of investment support on labour productivity. Travnikar and Juvančič (2013) arrived at the same conclusions after analyzing the impacts of investment support on farms in Slovenia, whereas Bartova and Hurnakova (2016) obtained essentially the same results for Slovak farms. However, Salvioni and Sciulli (2018) observed a different pattern for Italian farms as investment support did not lead to a growth in their labour productivity. According to these researchers, the main reason for this was short post-intervention period.

Currently, assessment of the effects of investment support is particularly important. This is mainly due to the initiated EU-wide debate on the Common Agricultural Policy (CAP) priorities and development needs beyond 2020 and the necessity of using the EU support effectively and creating the highest possible European value added. In this context, this paper aims to assess the impact of investment support on labour productivity in Lithuanian family farms. The following tasks are therefore set: 1) to present the framework for the assessment of the impact of investment support on labour productivity; 2) to reveal the main trends in investment activity and labour productivity in Lithuanian family farms; 3) to identify the effect of participation in investment measures on labour productivity in Lithuanian family farms.

The article is organised as follows. Section 1 introduces a methodological approach for assessment of the impact of investment support on labour productivity. Section 2 presents the results and discusses avenues for further research. The final part presents research conclusions.

1. Methodological approach

The research seeks to assess the impact of investment support on labour productivity in Lithuanian family farms. Therefore, drawing on previous research (e.g., Medonos *et al.*, 2012; Kirchweger *et al.*, 2015), propensity score matching is employed.

In order to estimate the propensity scores for each farm, we applied binary logistic regression, also called a logit model:

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \sum_{j=1}^{m} \beta_i X_{ij}, \tag{1}$$

where P represents the probability of an event occurring, X denotes the independent variables, β stands for the regression coefficients.

From a review of the literature, 9 variables were selected as factors affecting farmers' participation in investment measures: farmer's age (in years), total assets (in EUR), total labour input (in AWU), total liabilities (in EUR), total livestock units (in LU), net investment (in EUR), dummy variable for organic farming, income from sources other than farming (in EUR), and total subsidies (excluding on investment) (in EUR). There was no multicollinearity among the independent variables. Therefore, all these variables were incorporated in the model.

Although there are many algorithms to pair treated and control units (Strawiński, 2014), we used the most frequently applied technique, i.e., nearest neighbour matching, which selects for each treated unit i the control unit based on the closest distance between their propensity scores. Through these two steps, pairs consisting of one treated and one control unit were built and the control group which is identical to the treated group was generated.

Propensity score matching requires that two assumptions be met. The first assumption is the conditional independence assumption, which states that the potential outcome is independent of the treatment assignment (Guo, & Fraser, 2015):

$$(Y_{0i}, Y_{1i}) \perp (D_i|\mathbb{x}_i), \tag{2}$$

where Y_{1i} denotes the outcome if the i^{th} unit was treated, Y_{0i} represents the outcome if the i^{th} unit was not treated, D_i stands for a binary variable that equals 1 if the i^{th} unit was treated or 0 otherwise, $\mathbb{x}_i$ indicates a vector of observed characteristics for the i^{th} unit.

The second assumption that is required for matching is the overlap assumption, which means that there is overlap in the covariate distributions between the treated and control groups:

$$0 < P(D_i = 1|\mathbb{x}_i) < 1. \tag{3}$$

After verifying these assumptions, it is possible to identify the average treatment effect on the treated (ATT). The ATT was computed as the difference in mean outcomes of the treated and controls (Pawłowska, Bocian, 2017):

$$W_{ATT} = E(Y_{1i} - Y_{0i}|D_i = 1) = E(Y_{1i}|D_i = 1) - E(Y_{0i}|D_i = 1). \tag{4}$$

As noted in the literature (e.g., Power, 1998), there is often a considerable lags between the timing of investment and its impact on farm productivity. Therefore, we follow Pawłowska and Bocian (2017) and assume that farms' characteristics in period t affect the probability of participation in investment measures in period $t+1$ and labour productivity in period $t+2$. Based on prior research, we measured labour productivity as the total farm output per annual work unit (AWU) (in EUR/AWU).

The research was based on Farm Accountancy Data Network (FADN) dataset (Lithuanian Institute of Agrarian Economic, 2018). The analysis used a balanced panel for 2007–2012 covering family farms that received investment support as well as family farms that did not benefit from investment support. The panel consisted of 284 family farms. The period of analysis was determined by the availability of data (*Fig. 1*).

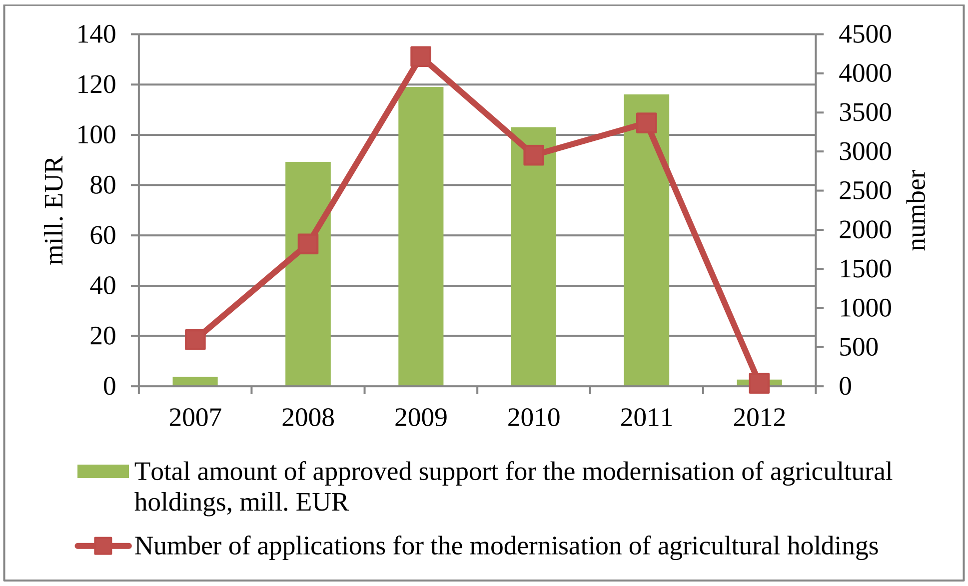

Figure 1. Number of applications for the modernisation of agricultural holdings and total amount of approved support for the modernisation of agricultural holdings in Lithuania, 2007–2012 (National Paying Agency, 2019)

Matching was performed in R using the Matching package.

2. Results

After Lithuania's accession to the EU in 2004, Lithuanian farmers started to receive substantial benefits from the CAP. Support payments under the CAP enabled farmers to actively invest in fixed assets.

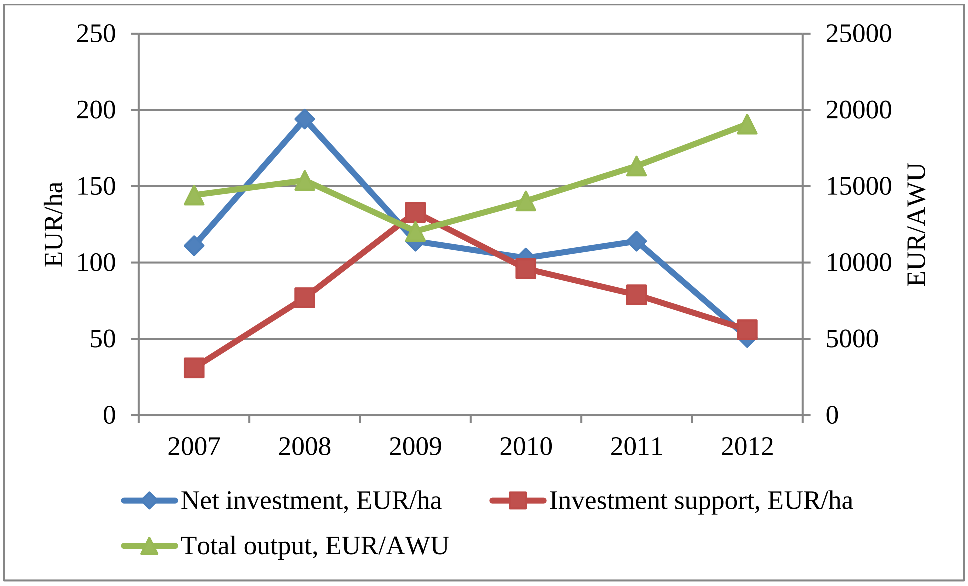

Figure 2. Net investment, support for investment and total output in Lithuanian family farms, 2007–2012 (Lithuanian Institute of Agrarian Economics, 2018)

More specifically, analysis of net investment in Lithuanian family farms shows that net investment in 2007–2012, on average, reached 115 EUR/ha. The lowest net investment was in 2012, whereas the highest net investment occurred in 2008. As can be seen in *Fig. 2*, the fall in net investment at the end of the period was mainly due to declining investment support. As regards the total output per AWU, it showed an upward trend during 2007–2012. This can be explained by both decreased labour input and increased total output.

In order to deliver insights into cross-country differences in family farms' investment activity and labour productivity, *Table 1* presents the key investment and production indicators for farms in selected EU member states. As can be seen in this table, in 2007–2012, the lowest investment support was observed in Denmark and Germany. On the other hand, the highest investment support intensity was in Lithuania. The opposite pattern, however, was identified for fixed assets. In this case, the new EU member states, namely, Latvia and Lithuania, exhibited the lowest value of fixed assets, whereas Denmark and Germany featured the highest value of this indicator.

Table 1. Key investment and production indicators for farms in selected EU member states, averages for 2007–2012 (European Commission, 2018)

Country	Investment support, EUR/ha	Net investment, EUR/ha	Machinery and buildings, EUR/ha	Total fixed assets, EUR/ha	Total output, EUR/AWU
Denmark	2	363	5 880	22 906	219 197
Germany	5	95	2 216	8 006	96 877
Latvia	29	81	636	1 075	21 563
Lithuania	79	115	1 005	1 510	18 777
Poland	12	0	2 924	6 033	15 892

As regards labour productivity, the lowest total output per AWU was achieved in Poland. At the other end of the spectrum, Denmark and Germany featured the highest values of total output per AWU. Therefore, it can be concluded that even labour productivity increased in the new EU member states, substantial cross-country differences persisted.

Table 2. Descriptive statistics for variables used in the logistic regression analysis

Variable	Mean	Standard Deviation	Minimum	Maximum
Farmer's age, years	46	11	20	85
Total assets, EUR	317 566	403 966	5 050	3 434 101
Total labour input, AWU	3.5	3.2	0.9	29.4
Total liabilities, EUR	103 401	176 914	0	1 585 494
Total livestock units, LU	35	69	0	567
Net investment, EUR	33 211	95 617	-285 191	1 067 249
Participation in organic farming, dummy	0.9	0.3	0	1
Income from sources other than farming, EUR	3 428	11 712	0	129 639
Total subsidies (excluding on investment), EUR	33 886	37 420	240	299 189

Note: Descriptive statistics of the whole sample.

As noted earlier, from a review of the literature, 9 variables were selected as factors affecting farmers' participation in investment measures. *Table 2* provides some descriptive statistics for all variables.

A closer look at these data indicates that the studied family farms had, on average, a large amount of total assets. The average value of total assets was 317 566 EUR, whereas the maximum one reached 3 434 101 EUR. Also, it is interesting to note that the average net investment amounted to 33 211 EUR. It should be noted, however, that some family farms had negative net investment.

Looking at the data in *Table 3*, one can notice certain differences between Lithuanian family farms receiving and not receiving investment support. During the research period, farms receiving investment support were, on average, larger in terms of utilized agricultural area than farms not receiving investment support. On the contrary, other indicators, such as capital intensity, differed in terms of magnitudes across the two groups of farms at the beginning and at the end of the research period.

As mentioned earlier, to estimate the propensity scores, a logistic regression model was used. As can be seen in *Table 4*, during the research period the probability of participation in investment measures was affected by various factors. For instance, at the beginning of research period the probability of participation in investment measures was higher among farms with a greater number of livestock units, while it was lower among farms that use more labour. In addition, participation in investment measures was more likely for pluriactive farms. This can be explained by the willingness of pluriactive farmers to substitute capital for labour. Finally, the probability of participation in investment measures was higher among farms that had a high initial net investment. This is mainly due to farmers' willingness to maintain high technological level.

Table 3. Selected characteristics of Lithuanian family farms receiving and not receiving investment support

Variable	2007		2010		Change 2010, compared to 2007, %	
	Farms receiving investment support	Farms not receiving investment support	Farms receiving investment support	Farms not receiving investment support	Farms receiving investment support	Farms not receiving investment support
Total utilized agricultural area, hectares	204.9	188.0	241.3	209.9	17.8	11.6
Total labour input, AWU	3.1	3.3	4.2	3.4	35.5	3.0
Number of livestock units per hectare of UAA	0.3	0.4	0.7	0.3	133.3	-25.0
Total assets per hectare of UAA, EUR	1 685	1 913	3 162	2 115	87.7	10.6
Total liabilities per hectare of UAA, EUR	394	409	481	342	22.1	-16.4

Table 4. Factors of farmers' participation in investment measures

Variable	2008	2009	2010	2011
Farmer's age	-0.003 (0.014)	-0.018 (0.013)	-0.019 (0.013) *	-0.021 (0.016)
Total assets	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Total labour input	-0.240 (0.109) **	-0.029 (0.068)	0.069 (0.058)	-0.067 (0.079)
Total liabilities	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Total livestock units	0.007 (0.003) ***	0.002 (0.003)	0.002 (0.002)	0.011 (0.003) ***
Net investment	0.000 (0.000) *	0.000 (0.000) ***	0.000 (0.000) *	0.000 (0.000) *
Participation in organic farming	-0.344 (0.460)	-0.121 (0.417)	-0.038 (0.423)	-0.973 (0.453) **
Income from sources other than farming	0.000 (0.000) *	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Total subsidies (excluding on investment)	0.000 (0.000)	0.000 (0.000) *	0.000 (0.000) *	0.000 (0.000)

Note: Cells contain binary logistic regression coefficients with standard errors in parentheses (*** p<0.01; ** p<0.05; * p<0.1).

Table 5 presents the results of ATT using nearest neighbour matching. As can be seen in this table, there was no any statistically significant effect of investment support on labour productivity in Lithuanian family farms. These findings, however, cannot be directly interpreted as evidence of ineffectiveness of investment support. One possible explanation for these findings is too short post-intervention period. For instance, such a case is described by Hugget and Ospina (2001) and Sakellaris (2004), who revealed that productivity improves only in the long run. Another reason for this may be that the research covered period of financial crisis, which changed farmers' investment behaviour and, thus, actual effects of investment support. On the other hand, however, based on the findings of earlier studies (e.g., Papageorgiou, 2015; Sass, 2017), it can be concluded that such results can also be caused by over-investment and inefficient use of capital.

Table 5. Effect (ATT) of investment support on labour productivity (in EUR/AWU)

Parameter Estimates	2009	2010	2011	2012
Estimate	5 549	5 714	4 982	5 605
Standard Error	296	360	316	911
p-value	>0.05	>0.05	>0.05	>0.05

Thus, these results provide some suggestions to policy makers with regards to decisions on investment support measures beyond 2020. The main conclusion emerging from this research is that current investment support measures based on a one-time subsidy should be replaced by other measures which do not encourage excessive investment (e.g., repayable investment support). Similar recommendations were offered by Polish and Czech researchers (e.g., Kulawik, 2016; Doucha *et al.*, 2017). This research, however, leaves room for further investigation into this question. Future research could be firstly aimed at considering a longer time span. Another field of future research could be the assessment of the impact of investment support on other farm performance indicators. And finally, based on the findings from the literature (e.g., Rosenbaum, 2005; Kirchweger, Kantelhardt, 2012), future research could examine the effects of investment support in groups of farms that are more homogeneous. Such research could help developing more accurate recommendations on the design of economic policy aimed at the modernization of agriculture.

Conclusions

In this research we employed a propensity score matching approach to assess the impact of investment support on labour productivity in Lithuanian family farms. In order to pair treated and control units, we used nearest neighbour matching. We assumed that farms‘ characteristics in period t affect the probability of participation in investment measures in period $t+1$ and labour productivity in period $t+2$. The research relied on panel data from FADN dataset. The data covered years 2007–2012.

The period of 2007–2012 marked an increase in investment in Lithuanian family farms. However, despite these changes, family farms in Lithuania lagged behind those in the developed countries (such as Denmark and Germany) in terms of key investment indicators. Cross-country differences in labour productivity were also observed. Indeed, total output per AWU in Lithuania amounted to 18 777 EUR/AWU in 2007–2012, whereas in Denmark and Germany it reached 219 197 EUR/AWU and 96 877 EUR/AWU, respectively.

Propensity score matching analysis showed no statistically significant effect of investment support on labour productivity in Lithuanian family farms. On the one hand, this can be explained by the limitations of the methodology used (e.g., too short post-intervention period). On the other hand, however, these results may be a sign of over-investment and inefficient use of capital. Further studies are therefore needed to clarify this issue and provide more accurate recommendations on the design of economic policy aimed at the modernization of agriculture.

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