Evaluation of investment support under Rural Development Programme 2014-2020 – preliminary results for Poland

ALEKSANDRA PAWŁOWSKA
Aleksandra.Pawlowska@ierigz.waw.pl
MONIKA BOCIAN
Monika.Bocian@ierigz.waw.pl
JOANNA JAROSZEWSKA
Joanna.Jaroszewska@ierigz.waw.pl

Institute of Agricultural and Food Economics – National Research Institute (Poland)

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Abstract

The aim of support under the second pillar of the CAP is to improve the economic situation of farms. The research objective of the study is to estimate the effect of support for investments under RDP 2014-2020 on an increase in labour productivity on Polish farms, defined as gross value added per annual work unit (GVA/AWU). The applied research tool is propensity score matching, enabling to calculate the average treatment effect for the treated (ATT). The study uses data from Polish FADN (Farm Accountancy Data Network) regarding individual farms.

Keywords: propensity score matching, labour productivity, farms, Rural Development Programme.

Introduction

The European Union and governments put particular emphasis on regional and national competitiveness due to its importance for the economic growth (EC, 2010). According to the definition provided by the European Commission, competitiveness consists in "a sustained rise in the standards of living of a nation or region and as low level of involuntary unemployment as possible" (EC, 2010: 15). According to the WEF (2014: 4), competitiveness is "the set of institutions, policies and factors that determine the level of productivity of a country". On the other hand, Latruffe (2010: 5) defines competitiveness as the "ability to face competition and to succeed against such competition" or as "the ability to sell products that meet demand requirements (price, quality, quantity) and, at the same time, ensure profits over time that enables the firm to thrive". According to OECD (2011), the degree to which entities achieve competitiveness depends on their operating environment. Factors listed here include: technological level, productive resources, including labour force, or institutional support. These factors influence the growth in the value of production and reduce the value of inputs, which is favourable for production efficiency.

Nevertheless, there is a need to stress that the element that is deemed crucial for sustained competitiveness is productivity growth (OECD, 2011). This results from the fact that productivity refers to the efficiency of the use of natural resources in the production of goods and services in the economy (Stocker et al., 2015). Labour productivity is the most reliable long-term indicator of competitiveness (EC, 2010). It is most often defined as the "ability of production factors to produce" (Latruffe, 2010: 18). Labour productivity is particularly determined by the amount of goods manufactured by people in a unit of time, and it allows the volume of production or services output per agricultural employee (Nowakowski, 1997).

The development of agriculture and its structural changes are less and less dependent on endogenous factors and more and more affected by sectoral policies, and primarily by the macroeconomic policy (Kowalski et al., 2014). Therefore, it is expected that the public policy will ensure competitiveness of farms (Latruffe, 2010). As observed by Domańska and Nowak (2014) competitiveness of agriculture in the European Union results primarily from the Common Agricultural Policy (CAP) and the European Single Market. These expectations are to be met through policy instruments ensuring increase in productivity, including measures under the Rural Development Programmes (RDP), which is part of the second CAP pillar (Regulation…, 2013).

The aim of this paper is to measure the impact of investment support for labour productivity on Polish farms. The studied measures are two types of operations under RDP 2014–2020, which were initiated in 2016, namely "Modernisation of agricultural holdings" (under sub-measure 4.1) and "Premiums for young farmers" (under sub-measure 6.1). In accordance with the assumption that aid is supposed to improve the economic situation of farms through co-financing of investments in technical equipment. These changes should then lead to an increase in gross value added and thus a growth in labour productivity. The impact of selected policy instruments has been assessed using propensity score matching.

Measures supporting investments on Polish farms

"Modernisation of agricultural holdings" is a kind of operation under the "Support for investment in agriculture holdings" sub-measure. The intended effect is improvement in competitiveness and increase in their profitability through partial reimbursement of the cost of investment related to agricultural activities and improving overall performance of the farm (PROW 2014-2020, 2017). The aid targets entities of the economic size ranging from 10,000 to 200,000 euro measured using the Standard Output (SO) coefficients[1]. Each operation should result in an increase of the gross value added (GVA) by at least 10% compared to the base year. The planned eligible cost should exceed PLN 50,000 with 50% (or 60% for an applicant who is a young farmer or for a joint application) but not less than 30% being reimbursed. In the programming period, the amount of aid has also been limited through the imposition of three limits: the basic limit of PLN 500,000, PLN 200,000 for investments not related to buildings used for livestock production, and PLN 900,000 where the operation concerns development of piglet production.

The support measure titled "Premiums for young farmers" targets persons younger than 40 who have relevant qualifications and are starting to operate a farm. The farm has to be characterised by an adequate economic potential between EUR 13,000 and EUR 150,000 in terms of the SO. Another eligibility criterion is the area of the farm, which should be at least equal to the national average (or the average for the voivodeship where it is lower than the national average) but not exceed 300 ha. The premium of PLN 100,000 is paid in two instalments. At least 70% of the amount has to be allocated to investment in fixed assets. The beneficiary commits to increase the economic size of their farm by at least 10% compared to the base period.

Methodology and data

An acknowledged method used for assessment of the impact of a specific factor (e.g. a policy instrument) on the resultant variable is a fully controlled randomised experiment, which allows for control of the so-called confounding variables, affecting the studied variable. To ensure randomisation of the experiment, the study has to be appropriately designed. The studied units are randomly assigned to the experimental or the control group, and this assignment does not depend on the effect of the impact. In the case of some disciplines, especially economic sciences, such an experiment is usually impossible due to technical, social or ethical constraints. Moreover, for entities functioning in the market environment, value of a specific resultant variable that is economic and financial in nature results from the impact of various factors and not only a single intervention. Furthermore, in the case of studies on the impact of policy instruments, the target groups of aid measures are selected in a non-random manner.

The solution is to use quasi-experimental methods, such as matching estimation. This approach is based on the analysis of the so-called counterfactual states, which are hypothetical values of the resultant value that are estimates approximating non-observed variable values. This results from the fact that the resultant variable can be defined as the sum of products of a binary variable indicating whether the specific impact is or is not present and a resultant variable, which takes a specific value depending on whether the unit has or has not been subjected to the impact of the analysed factor (Guo, Fraser, 2015):

[1] Standard Output (SO) is defined as the average value of specific crop or livestock production from 1 ha or 1 animal in 1 year in average conditions for the particular region over a period of 5 years.

$$Y_i = D_i Y_{1i} + (1 - D_i) Y_{0i} \tag{1}$$

where:
Y_i – outcome variable for the i^{th} object,
Y_{1i} – outcome variable if the i^{th} object was treated,
Y_{0i} – outcome variable if the i^{th} object was not treated,
D_i – binary variable that equals 1 if the i^{th} object was treated or 0 otherwise.

In reality, what is observed is the result of one of two mutually exclusive events, which is referred to as the fundamental problem of causal inference. For a specific unit in the experimental group (subjected to the factor), its counterfactual state will therefore be a unit in the control group (not subjected to the factor), which will be "similar" to it in terms of the adopted observed characteristics.

In its basic form, the data matching method requires coupling units from the experimental and the control group based on identical or similar values of characteristics, which is usually impossible in the case of continuous variables, hence the usual matching based on a balancing score, which is such a function of the observable characteristics that, given a specific balancing vector, the conditional distributions of those characteristics are identical for the experimental and the control group. The simplest balancing score is the propensity score. If data comes from observation, the balancing vector has to be estimated on the basis of the available data, which is done, e.g. by using logit model.

Use of the propensity score matching method requires satisfying the two basic assumptions. The first one is the conditional independence of the result from the subjection to impact (*conditional independence assumption*) (see Guo, Fraser, 2015):

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

where:
$\mathbb{x}_i$ – vector of observed characteristics for the i^{th} object.

The second assumption is the *overlap assumption*, which means that the distributions of the observable characteristics of units overlap in the experimental and the control group:

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

It is stated in the literature that conditional independence may only be tested using indirect methods, e.g. by estimating impact on such resultant variable that should not be affected by a specific factor. A non-zero impact would suggest violation of the assumption. The overlap assumption is usually tested primarily through a graphic analysis of distributions of the observed characteristics of units.

After combining observation and verification of the assumptions for the counterfactual method, it is possible to measure the impact of the studied factor on the resultant variable. Analyses of implemented policy instruments usually focus on assessing the impact of measures in place on the beneficiaries' situation and not the entire sample. Therefore, evaluation uses the average treatment effect for the treated (ATT)[2]:

[2] Assuming that if selection is present, this depends only on the observable characteristics of units (Strawiński, 2014).

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

It can be observed that the latter component of the difference is an unobservable value. It can, however, be estimated on the basis of the available data, assuming that the equality is satisfied (Strawiński, 2014):

$$E(Y_{0i}|D_i = 1) = E(Y_{0i}|D_i = 0) \quad (5)$$

The study has used the data from the Polish FADN (Farm Accountancy Data Network) concerning individual farms from the 2015–2016 period. The studied sample consisted of 52 farms in the treated (experimental) group and over 3,500 farms in the non-treated group, from which the control group was selected. The measured value was the impact of investment subsidies on labour productivity understood as the gross value added per annual work unit (GVA/AWU). Due to the limited data availability, it was assumed that the selected farm characteristics that were observable in 2015 affected the probability of being granted the subsidy in 2016, which resulted in specific labour productivity in 2016.

The propensity score vector has been observed on the basis of the logit model, which was used to estimate the impact of selected farm characteristics on the probability of being granted investment support. Explanatory variables were made of such a combination from the set of 16 variables for which the classification accuracy coefficient was the highest (Heckman et al., 1997)[3]. The superior goal, however, was to make farm characteristics so balanced in order to ensure their similar distributions in the experimental and the control group (Trzciński, 2009). Thus, where it was impossible to achieve a balanced model with the highest classification accuracy, the model selected for further analysis was the model characterised by a lower classification accuracy coefficient but ensuring that characteristics were balanced between the two groups.

The observations from the experimental group were matched with the non-treated units on the basis of the propensity score, i.e. the probability of obtaining investment support at specific values of selected farm characteristics. The units were matched on 1 to 1 basis using a genetic algorithm for seeking the best matches. The units were matched with replacement, so a unit in the non-treated group could be matched with at least one unit in the experimental group. Calculation was done in the R application using the “Matching” package.

Results

Table 1 shows the summary statistics for the observation matching, i.e. average values of the characteristics (for quantitative variables) or the percentage of units in the sample (for qualitative variables) for the experimental ($\bar{x}_T$) and the control group ($\bar{x}_C$), and the ratio of variance of the specific characteristics in the experimental group to the variance of that characteristic in the control group ($\frac{Var(x_T)}{Var(x_C)}$)[4].

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[3] Characteristics taken into consideration in the logit model included: specialisation type and economic size class of the farm, voivodeship, farm operator’s age and education, agricultural land area, agricultural land area excluded from agricultural production, in-house consumption as part of operations, cost of external factors, fixed and current assets, short- and long-term liabilities, change in equity in a financial year, average value of the farm’s capital, gross investment, and cash flow II (see Floriańczyk et al., 2017).

[4] For the qualitative variables, the first category is used as a reference, therefore, the application does not generate results for it.

Table 1. Balanced variables included in the propensity score model

Variable	before matching			after matching		
	$\bar{x}_T$	$\bar{x}_C$	$\frac{Var(x_T)}{Var(x_C)}$	$\bar{x}_T$	$\bar{x}_C$	$\frac{Var(x_T)}{Var(x_C)}$
Economic class size:						
very small						
small	0.288	0.137	1.774	0.228	0.277	1.024
medium-small	0.365	0.286	1.158	0.365	0.392	0.973
medium-large	0.192	0.355	0.691	0.192	0.139	1.3
large	0.154	0.213	0.792	0.154	0.192	0.839
very large	0	0.004	0	0	0	-
Type of farming:						
field crops						
horticulture	0	0.016	0	0	0	-
wine						
other permanent crops	0.019	0.038	0.525	0.019	0.009	2.226
milk	0.288	0.274	1.052	0.288	0.407	0.85
other grazing livestock	0.019	0.029	0.683	0.019	0.012	1.545
granivores	0.096	0.082	1.183	0.096	0.091	1.05
mixed	0.308	0.301	1.032	0.308	0.365	0.919
Voivodeship:						
Dolnośląskie						
Kujawsko-pomorskie	0.077	0.164	0.528	0.077	0.04	1.865
Lubelskie	0.038	0.089	0.465	0.038	0.011	3.334
Lubuskie	0	0.012	0	0	0	-
Łódzkie	0.154	0.081	1.789	0.154	0.118	1.254
Małopolskie	0.019	0.032	0.63	0.019	0.028	0.692
Mazowieckie	0.115	0.124	0.959	0.115	0.104	1.099
Opolskie	0.077	0.036	2.098	0.077	0.093	0.842
Podkarpackie	0.038	0.027	1.421	0.038	0.038	1
Podlaskie	0.135	0.076	1.689	0.135	0.275	0.584
Pomorskie	0.058	0.06	0.979	0.058	0.031	1.822
Śląskie	0.038	0.022	1.719	0.038	0.022	1.686
Świętokrzyskie	0.019	0.044	0.454	0.019	0.009	2.226
Warmińsko-mazurskie	0.038	0.027	1.436	0.038	0.064	0.616
Wielkopolskie	0.173	0.141	1.205	0.173	0.165	1.039
Zachodniopomorskie	0	0.025	0	0	0	-
Education of farmer:						
primary						
vocational school – other than farming	0.173	0.132	1.268	0.173	0.145	1.155
vocational school – farming	0.269	0.238	1.105	0.269	0.314	0.914
secondary – other than farming	0.077	0.116	0.708	0.077	0.043	1.72
secondary – farming	0.288	0.342	0.93	0.288	0.275	1.029
university – other than farming	0.096	0.04	2.289	0.096	0.087	1.1
university – farming	0.038	0.094	0.441	0.038	0.031	1.219
age of farmer [in years]	50.14	45.17	1.221	50.14	49.12	1.214
total utilised agricultural area [in ha]	32.69	47.03	0.331	32.69	33.63	0.873
total livestock units [in LU]	31.91	39.07	0.442	31.91	36.74	0.975
farm use [in PLN]	35,580	31,641	2.088	35,580	35,465	1.226
total external factors [in PLN]	15,821	19,970	0.985	15,821	14,225	1.153
total assets [in PLN]	1,412,809	1,826,517	0.445	1,412,809	1,329,325	0.922
total liabilities [in PLN]	159,159	187,077	0.745	159,159	159,830	0.775
change in net worth [in PLN]	14,890	7,672.2	0.547	14,890	-17,326	1.365
average farm capital [in PLN]	727,910	945,847	0.596	727,910	709,891	0.941
gross investment on fixed assets [in PLN]	82,722	65,890	0.67	82,722	64,994	1.163
cash flow [in PLN]	54,825	92,075	0.437	54,825	76,994	1.055

Source: own elaboration based on the FADN data.

When estimating the impact of the 2016 investment subsidies on labour productivity (GVA/AWU) in the same year, based on the farm characteristic as of 2015, the experimental and control group were, finally, balanced for such characteristics as: economic size class and farm specialisation type, voivodeship, farm operator's age and education, agricultural land area, total livestock, in-house consumption, cost of external factors, total assets, total liabilities, change in equity, average value of farm capital, gross investment, and cash flow.

Among the treated units, there were about 29, 37, 19 and 15% of farms classified in terms of the economic size class as small, medium-small, medium-large and large, respectively. In the non-treated group, the percentages of farms in particular size class groups was: 14, 29, 36, and 21%, respectively. Matching resulted in balanced percentages of farms in specific economic size classes in the experimental and the control group.

The experimental groups included 2, 29, 2, 10 and 31% of farms specialising in: permanent crops, dairy cows, other grazing livestock, granivores, and mixed production, respectively. Prior to matching, the percentages of farms in particular specialisation types was: 4, 27, 3, 8, and 30%, respectively.

Among the unit in the treated group, the highest percentages of farms were located in Mazowieckie (11.5%), Podlaskie (13.5%) and Wielkopolskie Voivodeships (17.3%). Prior to matching, the non-treated group included about 12.4% farms from Mazowieckie Voivodeship, 7.6% farms from Podlaskie Voivodeship, and 14.1% farms from Wielkopolskie Voivodeship.

Moreover, before matching, among the farms that did not receive the analysed subsidies, there were 13, 24, 12, 34, 4 and 9% farms whose operators had non-agricultural vocational education, agricultural vocational education, secondary agricultural education, non-agricultural higher education, and higher agricultural education, respectively. Among farms that were beneficiaries of investment support, these percentages amounted to: 17, 27, 8, 29, 10, and 4% respectively.

Prior to matching, the difference in the farm operator's age was about 5 years. After matching, it was reduced to a year.

Before selecting farms from the non-treated group for control group, the average agricultural land area was about 47 ha and was by about 14 ha larger than the average agricultural area used by farms in the experimental group. After matching, the average agricultural land area in the control group was about 33 ha.

Prior to matching, the difference between the analysed farms in terms of livestock on farms was about 7 LU. Matching allowed this difference to be reduced to about 5 LU.

In the case of such characteristics as: in-house consumption, cost of external factors, total assets, total liabilities, change in the value of equity, average value of farm capital, gross investment, and cash flow, the absolute difference between the farms in the experimental and in the non-treated group amounted to: PLN 4,000, PLN 4,000, PLN 400,000, PLN 30,000, PLN 7,000, PLN 230,000, PLN 17,000, and PLN 37,000, respectively. For the balanced experimental and control sets, these differences amounted to: PLN 100, PLN 1,600, PLN 90,000, PLN 600, PLN 32,000, PLN 20,000, PLN 18,000, and PLN 22,000, respectively. After the propensity score matching, similar average values of variables in the experimental and the control group were also accompanied by similar variance for each variable (category).

For such a balanced experimental and control group, it was possible to measure the effect of investment support under RPD 2014–2020 on labour productivity on farms. The value of the average effect on the treated units was 43,821. Therefore, farms that received the analysed subsidies in 2016 achieved about PLN 44,000/AWU higher labour productivity compared to farms that did not benefit from such support. The difference in labour productivity between the experimental and the control group was statistically significant at each standard significance level.

Conclusion

What is deemed to be crucial for ensuring lasting competitiveness is increase in productivity. For single farms and the entire agricultural sector, this growth is possible to achieve through the implementation of appropriate policy instruments. In the case of the Rural Development Programme 2014–2020, which is part of the second CAP pillar, measures intended to support such increase include e.g. two operation types: "Modernisation of agricultural holdings" and "Premiums for young farmers". Such support should contribute to the improvement in the economic situation of farms through co-financing of investments, which results in increased technical equipment. These changes should then lead to an increase in gross value added and thus a growth in labour productivity.

In this work, propensity score matching was used to measure the effect of investment spending on labour productivity on Polish farms in 2016. The results have shown that the studied subsidies had favourable impact on labour productivity. In 2016, the beneficiaries of the "Modernisation of agricultural holdings" and the "Premiums for young farmers" measures achieved labour productivity that was on average about PLN 44,000/AWU higher than farms that did not benefit from such aid in that year. The difference between farms that benefited from support (the experimental group) and the "similar" farms that did not benefit from the analysed subsidies (the control group) was statistically significant.

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