ANNALS OF THE POLISH ASSOCIATION OF AGRICULTURAL AND AGRIBUSINESS ECONOMISTS

received: 10.10.2019
acceptance: 02.12.2019
published: 15.12.2019

Annals PAAAE • 2019 • Vol. XXI • No. (4)

JEL codes: N50, O13, Q13

DOI: 10.5604/01.3001.0013.6094

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POLISH AND ROMANIAN DAIRY FARMS USING EU INVESTMENT SUPPORT: A COMPARATIVE STUDY[1]

Key words: investments, dairy farms, Common Agricultural Policy, FADN

ABSTRACT. The purpose of this paper was to compare the investment amounts and efficiency of productive input between Polish and Romanian dairy farms depending on whether they access funds under the second pillar of EU's CAP. The study covered the particularities of farms who access investment funds under the 2nd pillar of EU's CAP, which allowed to identify the differences between beneficiaries and the control group (i.e. non-beneficiary farms). This paper relies on unpublished 2004–2015 microdata at a farm level, as retrieved from the FADN of the European Commission's Directorate-General for Agriculture and Rural Development (DG AGRI-C.3; data source: EU-FADN – DG AGRI). The analysis period starts from the moment the two countries joined the EU and launched the FADN system (which is 2004 for Poland and 2007 for Romania) and ends in 2015. The research task defined for Polish and Romanian dairy farms was performed with the use of Propensity Score Matching, a counterfactual method. The calculations were carried out using STATA. As shown by the analysis, in Poland, no considerable differences existed between dairy farms run by the beneficiaries of EU investment funds and the control group. Conversely, in Romania, investment aid was accessed by farms demonstrating a more efficient use of productive input.

INTRODUCTION

The particularities of the agricultural sector, resulting from the very nature of agricultural production and macro- and microeconomic conditions for the functioning of agriculture [Czyżewski 2019], provide grounds and a justification for sectoral intervention policies put in place by the government. The forms of aid include agricultural support programmes. Farms maintain or increase their production capacity through investments [Bórawski et al. 2019, Józwiak 2004]. In agriculture, investments are defined as the purchase of any additional fixed asset which is supposed to support, either directly or indirectly, the objective function of an operator, which is to maximize production and economic benefits [Brandes, Odening 1992, p. 6, Babuchowska, Marks-Bielska 2012, Żak 2013]. Investing

[1] This article was supported by the National Science Centre, Poland [UMO-2018/31/N/HS4/03052]. Data source: EU-FADN – DG AGRI.

is a continuous process of renewing and expanding tangible assets [Klepacki 1999, Żak 2013]. In many European Union countries which joined the EU after 2000, accession marked an increase in their investment expenditure. This was caused by a greater amount of Union funds allocated to agricultural policy, and the need to modernize farms and make production compliant with the requirements of the single European market. This was the case for Poland and Romania, especially in their dairy sectors. Indeed, the milk production sector witnessed progressive structural transformation, and the requirements for producers and processors stimulated a continuous modernization process. Agricultural investments were of key importance for the ability to maintain and develop milk production in Poland and Romania [Jóźwiak, Kagan 2008, Mikołajczyk 2017, Żak 2013]. This is due to the fact that agriculture, in both countries, is severely affected by agrarian fragmentation, and many farms are at low levels of technological development [Czubak et al. 2010]. Therefore, the funds allocated to agriculture, under the Common Agricultural Policy, and related investments made in agricultural holdings, including dairy farms, were supposed to provide momentum for structural changes in and the modernization of farms. Polish and Romanian dairy farms operate under different investment conditions. The differences can be inherent to an individual farm, but may also be driven by conditions created by the environment. Investment targets and goals are determined by the characteristics of a farm itself, and by the conditions of the natural environment where a farmer is active. This implies the need for providing a farm with the right agricultural equipment: machinery, necessary production appliances or livestock buildings together with their equipment. Investment decisions largely depend on a business manager's (in this case, the farmer's) propensity to invest, knowledge, development vision and risk-bearing capacity. Nevertheless, a favorable environment has an effect on farmers' decisions to make investments. Agricultural investment targets include the introduction of new technologies, the adaptation of innovative solutions, a reduction of costs and environmental impacts, production quality improvements, shifting to another line of production or diversifying the farming business [Gołębiewska 2010, Zając 2012].

Note, however, that investments not only affect individual development but are also related to structural changes from a macroeconomic perspective [Czubak et al. 2010]. For Poland and Romania, joining European Union structures provided an opportunity to access support programmes for farming investments. Dedicated aid was already available under pre-accession schemes and, afterwards, in subsequent Rural Development Programmes. Findings from scientific research suggest that support for agricultural investment activities is related to agriculture being an inefficient sector, which is at a relative disadvantage in the market while having an important role to play in the economy and society [Gorzelak 2010, Aceleanu et al. 2015, Seremak-Bulge 2010]. Support for agricultural competitiveness is covered by measures taken under the EU's CAP, which means the authorities are aware of such needs. In Poland and Romania, using the funds provides an opportunity to restructure farms, modernize agricultural production processes, accelerate transformation and technological advances in agriculture, align farms with the requirements of the single market and improve their competitiveness [Czubak 2012, MRiRW 2004, 2004b, 2011]. The role of science is to evaluate the outcomes of agricultural policies. One of the elements affecting the effectiveness and effects of intervention consists of defining the characteristics of operators who access available policy instruments. In this context, the main goal of this paper was to determine the investment amounts and efficiency of productive input of Polish and Romanian dairy farms. The study covered the characteristics of farms which access investment funds under the second pillar of the EU's CAP, which allowed to identify the differences between the beneficiaries of investment measures available under the second pillar of the CAP and the control group. Poland and Romania were chosen for this comparative study because both countries have a very large total number of farms (including a similar number of dairy cow farms), are affected by agrarian fragmentation (which is also true for dairy farms) and, therefore, face similar challenges when competing in the EU's single market

RESEARCH METHODS

The essential part of the analyses could be done thanks to access to unpublished FADN microdata at farm level. This paper relies on unpublished 2004-2015 data for Poland and 2007-2015 data for Romania (starting from the year the countries surveyed joined the EU), and uses microdata delivered through restricted access to the FADN of the European Commission's Directorate-General for Agriculture and Rural Development (DG AGRI-C.3, data source: EU-FADN – DG AGRI). Dairying farms (type 5 according to the TF8 FADN classification) were selected from all the available farm groups. As a next step, farms were divided into the beneficiaries pool and the control pool as per the formula below:

$$PIM = \begin{cases} 0, & \text{if} \quad \sum_{t_0}^{t_1} SIV_t = 0 \\ 1, & \text{if} \quad \sum_{t_0}^{t_5} SIV_t \geq 5{,}000 \quad \& \quad SIV_{t_0} = 0 \end{cases}$$

where: *PIM* – Pro-Investment Measures (thus, of the entire range of activities taken under the second pillar of the CAP, the most important one included in "SE406 Investment subsidies" is 121 "Modernization of agricultural holdings"), *SIV* – Subsidies on the Investment Value (SE406 in the FADN database).

Hence, only farms that had at least six years of continuous records in the FADN database were accepted for this study. The control pool included farms that did not receive any investment support under the second pillar of the CAP during the six-year period under review. In turn, the experimental group (beneficiaries) comprised farms which met the continuity requirement, accessed support for the first time in year t_1, and received a total of no less than EUR 5,000 within the following 5 years. The number of beneficiaries and control pools is presented in Table 1. Obviously, it would be best to examine farms with continuous records throughout the study period. However, should this criterion be applied, the number of Romanian farms would drop to a total of 19 in both groups altogether. Therefore, it would be impossible to publish the results (DG AGRI guidelines allow for the publication of aggregated results for at least 15 farms).

Table 1. The population of the experimental and control pools

Treatment	Poland	Romania
Untreated	15,031	2,853
Treated	1,405	61
Total	16,436	2,914

Source: own calculations based on unpublished data: EU-FADN – DG AGRI, STATA 15

Propensity Score Matching was the method used to meet the objective of this paper, defined as determining the particularities of Polish and Romanian dairy farms which access investment funds under the 2nd pillar of the EU's CAP. The matching-based estimation consists of analyzing counterfactual conditions, i.e. hypothetical values of the outcome variable. When considering the impact of a treatment on the outcome variable, calculating the magnitude of that impact means determining the effect one treatment would have had on a unit which, in fact, received some other treatment. Therefore, in the counterfactual approach, the outcome variable may be defined as:

$$Y_i = D_i Y_{i1} + (1 - D_i) Y_{i0} \qquad D \in \{0, 1\}$$

where: Y_i – the value of the outcome variable for unit *i*, Y_{i1}, Y_{i0} – values of the outcome variable in the case where unit *i* either received a treatment or did not receive it (respectively), D_i – a Boolean variable which is 0 if unit *i* did not receive the treatment or 1 otherwise.

In the counterfactual PSM method, each object can be associated with the probability that it will be impacted (in this case, by the use of CAP investment funds) based on defined input variables which form the propensity score vector. Next, the farms are paired based on the similarity of the estimated probability, resulting in the creation of two (statistically) identical groups: the beneficiaries and the control group.

Table 2. Results yielded by PSM used in matching beneficiaries of investment funds disbursed under the second pillar of the CAP to the control group of non-beneficiary farms in Poland*

Variable	Unmatched (U)/ Matched (M)	Mean		% bias	% reduct |bias|	t-test	
		treated (T)	control (C)			t	p >|t|
Labor input [AWU]	U	2.201	2.2017	0		-0.01	0.993
	M	2.201	2.2017	0	0	-0.01	0.993
Agricultural area [ha]	U	35.54	36.017	-0.8		-0.2	0.838
	M	35.54	36.017	-0.8	0	-0.2	0.838
Capital [EUR]	U	170,000	180,000	-1.5		-0.41	0.682
	M	170,000	180,000	-1.5	0	-0.41	0.682

* Due to the database being extremely large and because of limitations of the STATA suite, Polish farms were merged separately each year. Next, the farms were merged into a single group which means that matching errors were not reduced in the final merger.

Source: own calculations based on unpublished data: EU-FADN – DG AGRI. STATA 15

The initial situation of and the differences between the two groups of farms[2] (the beneficiaries and the control group) were determined for the year which preceded the use of investment funds (t_0). This allowed to avoid the distorting impact of investment subsidies received on the farms' economic standing. The input variables of the PSM vector were set as: utilized agricultural area in hectares (SE025), labor input in AWU (SE010) and gross fixed assets other than land (SE441–SE446). As a consequence, the farms paired had a similar production potential (a similar value of productive input) in year t_0. In year t_1, one of them started to access investment funds under the 2nd pillar of the CAP (the experimental group), while the other one (the control group) did not. As a consequence, each of the two groups comprised 1,405 farms (in Poland) and 61 farms (in Romania). The difference in the size of the groups is mostly due to the difference in the continuous presence of respective farms in the FADN database.

Propensity Score Matching was performed in STATA. The results of matching, including the average values of variables before and after matching, percent errors, error reduction and statistical significance tests are shown in Tables 2 and 3. In summary, the PSM method allowed to create two groups (the beneficiaries and the control group) for each country. As they do not significantly differ in average indicators (of labor, land and capital), they are statistically identical.

Table 3. Results yielded by PSM used in matching beneficiaries of investment funds disbursed under the second pillar of the CAP to the control group of non-beneficiary farms in Romania

Variable	Unmatched (U)/ Matched (M)	Mean		% bias	% reduct |bias|	t-test	
		treated (T)	control (C)			t	p > |t|
Labor input [AWU]	U	1.8259	2.6939	-16.7		-1.19	0.233
	M	1.8259	1.6891	2.6	84.2	0.2	0.838
Agricultural area [ha]	U	15.968	39.285	-27.7		-1.61	0.107
	M	15.968	15.927	0	99.8	0.01	0.996
Capital [EUR]	U	65,267	110,000	-9.7		-0.57	0.571
	M	65,267	30,115	7.2	25.7	1.21	0.227

Source: own calculations based on unpublished data: EU-FADN – DG AGRI, STATA 15

RESULTS OF THE STUDY

In Poland and Romania, milk production and processing play a crucial role; dairying and milk production are among the traditional lines of production (the value of cow milk production in 2016 in Poland and Romania amounted to 13.7% and 11.4%, respectively, of the total value of agricultural output [FAOSTAT 2019, EUROSTAT 2019]). The Polish and Romanian dairy sectors are an extremely important source of income for a consider-

[2] In assessing the results for both examined groups, i.e. beneficiaries and selected control farms, analysis of variance was used to show statistically significant differences of means in separate groups. The null hypothesis on the equality of group means was verified with the Fisher-Snedecor F test.

able number of farms [Grodea 2016, Judzińska 2016, INSSE 2008, Nistor et al. 2010]. The assessment of changes that have taken place in both countries after EU accession provides an important context for the analyses of the situation of dairy farms. Note that these changes are not homogeneous in the two countries. From 2000 to 2017, Poland and Romania witnessed a clear decline in cow numbers [FAOSTAT 2019]. In both countries, the main reason behind that trend was the discontinuation of milk production by small farms that were unable to adjust their production conditions to the standards of the EU's single market, primarily because of the extent and high costs of necessary modernization investments. These developments were exacerbated by pressures from milk processing factories caused by the need to optimize milk purchasing costs and expectations for raw materials delivered by suppliers [Popescu 2017, Vladu, Panzaru 2017]. Nevertheless, these changes did not reduce the high degree of fragmentation. Currently, the average number of cows per farm in Romania and Poland is 2.4 and 8.7, respectively [EDA 2019]. Obviously, the reduction in cow numbers does not necessarily mean a decline in milk production because milk yield may grow in parallel. Considerable differences in that respect were found to exist between Poland and Romania. In Poland, since 2000, the decline in cow numbers has been accompanied by growth in milk production. In 2017, milk production in Poland was 13.7 billion liters [GUS 218], i.e. over three times more than in Romania [EDA 2019]. Conversely, in Romania, the decline in animal numbers was accompanied by a downturn in milk production after its accession to the EU. Lower cow numbers did not go hand in hand with improvements in the quality of breeding animals or higher milk yield [Popescu 2017, Ricard 2016]. While milk yield nearly doubled in Poland, the growth rate in Romania was much smaller, though positive. As a consequence, milk yield in Poland is twice as high [GUS 2018]. In 2012 and 2013, persistent drought had an adverse effect on milk production in Romania as it contributed to a reduction in the production volume of feeding stuffs [Morna 2016, Popescu 2017]. Ultimately, milk production in Romania went down by one-quarter from 2007 to 2017 [FAOSTAT 2019].

While the total number of farms in Romania was twice as high as in Poland, the number of dairy farms was similar. According to FAOSTAT data, there were slightly over 100,000 dairy farms in Poland in 2016, most of which operated on a commercial basis. In turn, Romania had ca. 140,000 dairy farms in 2016 but the vast majority of them (ca. 80%) only produced milk for their own purposes. In both countries, dairy cow farms are mostly small operators. However, the structural situation in Romania is much worse in that respect: the country is dominated by small farms operating on an area of 1-2 ha and keep one or two cows. The production capacity of the Romanian dairy sector is determined by the current few large and very large farms which apply animal welfare standards and rely on state-of-the-art technologies to meet the EU requirements. As a consequence, they are able to deliver raw milk to processors [Popescu 2017].

Considering the fact that the structural transformation of dairy farms in both countries was largely driven by European integration, this paper analyzed the importance of CAP funds in farm investment processes. The PSM method described above was used to divide the dairy farms selected for the analysis into two groups. The next step was an analysis of investment levels, fixed assets structures and productive input efficiency in farms located in the two countries.

Table 4. Investments in Polish and Romanian dairy farms (EUR) in the base year (preceding the beneficiaries' access to funds available under the second pillar of the CAP)

Investment value [EUR]	Poland			Romania		
	beneficiary	control	statistical significance of differences	beneficiary	control	statistical significance of differences
Gross amount per farm	18,154	15,975	F = 2.3825 p = 0.1228*	719	921	F = 0.0587 p = 0.8090*
Net amount per farm	15,512	14,476	F = 0.9470 p = 0.3306*	-550	-353	F = 0.0749 p = 0.7848*
Per hectare of agricultural land	511	444	F = 3.7448 p = 0.0491**	57	90	F = 0.7295 p = 0.3950*
Per AWU	8,248	7,256	F = 0.7541 p = 0.3852*	489	537	F = 0.5704 p = 0.4516*
Per EUR 1 worth of fixed assets (other than land)	0.11	0.09	F = 11.3997 p = 0.0007**	0.03	0.03	F = 0.4339 p = 0.5114*
In relation to the value of (total) fixed assets	0.07	0.06	F = 13.5632 p = 0.0002**	0.02	0.02	F = 1.1067 p = 0.2950*

Source: own calculations based on unpublished data: EU-FADN – DG AGRI

The findings suggest that investment levels in Polish dairy farms were much higher than in Romania, both in absolute and relative terms (Table 4). The differences between the countries compared exist both between farms using EU[3] funds and between non-beneficiary farms[4] (the control group). This means that, in Poland, EU funds were used by agricultural holdings which implemented significant investments regardless of EU support in the year preceding the disbursement of EU funds (the differences were statistically significant mostly for relative investment values). In Romania, on the other hand, no statistically significant differences in the amount of investments were found between the group of beneficiaries and the control group.

Another element covered by this analysis was the structure of fixed assets in Polish and Romanian dairy farms (Figure 1). As shown by research, Poland exhibited small differences between the beneficiaries of investment funds and the control group. Conversely, noticeable differences existed in Romania: the farms of beneficiaries had a greater value of buildings and livestock, while the control group demonstrated a greater share of land and machinery. Note also the significant differences in the structure of fixed assets between Poland and Romania. While the share of land and buildings was similar, the proportions for other components were different. In Romania, livestock value was of a much greater importance than in Poland.

[3] The differences were statistically significant (gross investment value per farm: F = 12.4288; p = 0.0004; net investment value per farm: F = 16.8300737; p = 0.0000).

[4] The differences were statistically significant (gross investment value per farm: F = 9.49033; p = 0.0021; net investment value per farm: F = 18.1299; p = 0.0000).

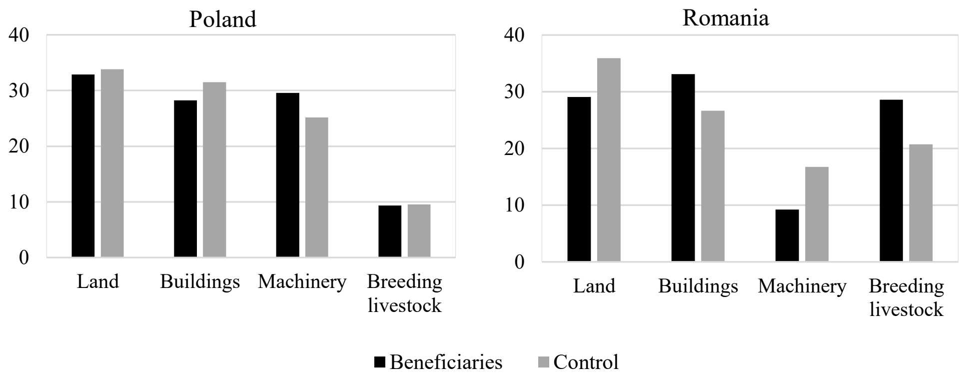

Figure 1. Structure of fixed assets in Polish and Romanian farms in the base year (preceding the beneficiaries' access to funds available under the second pillar of the CAP)

Source: own calculations based on unpublished data: EU-FADN – DG AGRI

Agricultural investments always involve large one-off investment expenses which, in turn, entail a number of additional costs. Accessing external financing also means higher interest costs as well as depreciation and insurance expenditure. The positive consequence is the growth of production potential. However, before the investment outcome becomes visible, a decline in efficiency may be experienced. Therefore, it can be assumed that operators at higher levels of efficiency generally have a greater investment capacity. They are in a privileged position when it comes to using support funds accessed under agricultural policy measures. This is because the assumption was made that optional investment support funds are sought by managers of farms with higher-quality human capital. Higher qualifications and greater experience are not only manifested in the ability to use funds but also – at an operating level – by better production outcome. Under this assumption, a comparison was made of the efficiency of productive input used between the beneficiaries and the control group (Table 5).

Outcome was measured using gross value added and farm income per unit of productive input used. Generally, as shown by the comparative analysis, no considerable differences existed between dairy farms run by the beneficiaries and the control group in Poland (except for the difference in the return on capital which proved to be statistically significant). This means that farms run by beneficiaries of funds allocated under the 2nd pillar of the CAP are not necessarily better or more efficient (contrary to common perception). However, the situation was somewhat different in Romania. Farms with higher labor and capital profitability benefited from investment funds disbursed under the CAP. This means that EU funds went to operators[5] who already generally had higher asset productivity and a higher financial surplus generated by everyone employed on the farm.

5 According to the methodology adopted, the analysis is carried out for the year preceding the use of support (t_0).

Table 5. Efficiency of productive factors in Polish and Romanian dairy farms (EUR) in the base year (preceding the beneficiaries' access to funds available under the second pillar of the CAP) in the group of beneficiary and control farms

Indicator	Poland			Romania		
	beneficiary	control	statistical significance of differences	beneficiary	control	statistical significance of differences
Gross value added						
Per hectare of agricultural land	1,102	1,095	F = 2.6865 p = 0.1013*	1,822	1,636	F = 0.6712 p = 0.4145*
Per AWU	17,788	17,905	F = 2.1123 p = 0.1462*	15,699	9,727	F = 2.1737 p = 0.1431*
Per EUR 1 worth of fixed assets	0.23	0.23	F = 0.5765 p = 0.4478*	0.82	0.54	F = 1.6370 p = 0.2033*
Farm income						
Per hectare of agricultural land	793	740	F = 1.4767 p = 0.2244*	1,599	1,093	F = 0.9332 p = 0.3363*
Per AWU	12,800	12,108	F = 0.2696 p = 0.6037*	13,772	6,497	F = 3.9696 p = 0.0487**
Per EUR 1 worth of fixed assets	0.16	0.15	F = 9.5770 p = 0.0020**	0.72	0.36	F = 4.5791 p = 0.0345**

Source: own calculations based on unpublished data: EU-FADN – DG AGRI

SUMMARY AND CONCLUSIONS

Despite some considerable differences, dairy farms play an important role in both Polish and Romanian agriculture. While the percentage of commercial dairy farms differs between the two countries, dairying largely contributes to the income of certain farmers. Support available under investment funds of the 2nd pillar of the EU's Common Agricultural Policy made it possible to upgrade farms through restructuring and modernization efforts. This, in turn, should translate, above all, into an increase in their production potential. As shown by research, even though Poland witnessed a decline in dairy cow numbers following its accession to the EU, milk production went up. This was possible because of the increase in milk yield. Conversely, in Romania, the decline in animal numbers was accompanied by a sluggish increase in milk yield, resulting in a decrease in total milk production volume. This may suggest that Polish dairy farms have made better use of opportunities brought by their accession to the EU. This trend is also confirmed by the results of the PSM analysis, showing that, in Poland, EU funds were used by agricultural holdings which implemented significant investments regardless of EU support in the year preceding the disbursement of EU funds. In Romania, on the other hand, no statistically significant differences in the amount of investments were found between the group of beneficiaries and the control group.

The comparative analysis provides grounds for concluding that no considerable differences existed between dairy farms run by the beneficiaries of EU investment funds and the control group in Poland. It follows that the decision to make use of aid funds was primarily influenced by external conditions of using the funds, such as the regional availability of investment loans, boundary conditions for using the programme or individual preferences of farmers. In Romania, however, investment support was sought by farmers who were more efficient in using productive input (especially labor and capital, for which statistically significant differences were found between the group of beneficiaries and the control group).

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INWESTYCJE W GOSPODARSTWACH MLECZNYCH W POLSCE I RUMUNII – ANALIZA PORÓWNAWCZA

Słowa kluczowe: inwestycje, gospodarstwa mleczne, Wspólna Polityka Rolna, FADN

ABSTRAKT

Celem artykułu jest porównanie poziomu inwestycji i efektywności czynników produkcji w gospodarstwach mlecznych w Polsce i Rumunii w zależności od wykorzystania środków II filaru WPR UE. Określono charakterystykę gospodarstw korzystających z proinwestycyjnych funduszy II filaru WPR UE i wskazano różnice między beneficjentami proinwestycyjnych funduszy II filaru UE a grupą kontrolną, którą tworzyły gospodarstw niekorzystające z tego wsparcia. W badaniach wykorzystano niepublikowane, indywidualne dane gospodarstw pochodzące z bazy FADN Dyrekcji Generalnej ds. Rolnictwa i Rozwoju Wsi Komisji Europejskiej (DG AGRI-C.3, Data source: EU-FADN – DG AGRI). Zakres czasowy analiz dotyczył okresu od akcesji do UE i rozpoczęcia prowadzenia systemu FADN (co dla Polski oznacza rok 2004, a dla Rumunii 2007) do 2015 roku. Zadanie badawcze dotyczące polskich i rumuńskich gospodarstw mlecznych zrealizowano z wykorzystaniem kontrfaktycznej metody Propensity Score Maching, a obliczenia wykonano w programie STATA. Przeprowadzona analiza wykazała, że w Polsce gospodarstwa mleczne beneficjentów środków proinwestycyjnych UE oraz kontrolne nie różniły się znacząco w zakresie efektywności wykorzystania czynników produkcji. Natomiast w Rumunii po pomoc proinwestycyjną sięgali rolnicy, których gospodarstwa charakteryzowały się wyższą efektywnością wykorzystania czynników produkcji.

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