



Territorial differences in agricultural investments co-financed by the European Union in Poland

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ABSTRACT

This paper identifies the relationship between an active use of EU investment support programs by Polish farmers, on one side, and the local conditions for socioeconomic development and natural and structural characteristics of agriculture, on the other. The research was illustrated by the example of Poland, a country with a remarkably fragmented and territorially heterogeneous agrarian structure. This study was carried out at commune level, and used a series of variables to describe the socioeconomic development levels of communes, natural conditions for farming and the agrarian structure. These characteristics were compared with the farmers' activity in accessing EU funds allocated to farm modernization. The Hellwig's synthetic development indicator was used to represent complex phenomena. A strong relationship was found to exist between the implementation of co-financed investments and the agrarian structure at local level. Other factors proved to be insignificant. This suggests that the agricultural development path is somewhat independent from socioeconomic and environmental conditions.

1. Introduction

The changes affecting social development, including rural development in highly and medium developed countries, have resulted in a gradual decline in the importance of agriculture over the last few decades (Prandacki and Floriańczyk, 2014; Lanz et al., 2016; FAO, 2017). Technologically driven processes such as production concentration, specialization, commercialization and shift to non-agricultural activities (Wilkin, 2010; Zegar, 2012; Pilgeram, 2013) all contribute to a considerable reduction in demand for farming labor while stimulating multifunctional development of rural areas which progressively move away from being limited to food production (Wilson, 2001; Kristensen et al., 2004; Hazel, 2007; Wilkin, 2010). Instead, rural areas become a place where people live, run non-agricultural businesses and relax (Weaver, 2004; Duarte, 2010; Duarte and Northcote, 2013; Baum, 2011; Sadowski, 2012; Wojcieszak, 2017; Yang, 2017; Kiryluk-Dryjska et al., 2020). Similar patterns can also be observed at macro level which witnesses a decline in the share of agriculture in the basic economic parameter such as GDP, to name just the most important one (Tomczak, 2000; Van Huylenbroeck and Durand, 2003; Cazaux et al., 2007). Nevertheless, agriculture has for thousand years steadily provided raw materials essential for human biological survival, which alone makes it a strategic business from the social perspective, even though it becomes less and less important for

the economy. Also, agriculture is intrinsically linked to rural areas, primarily because much space is required for production processes. Neither the multifunctional rural development nor modern systems such as vertical or urban agriculture (Sun et al., 2011; Ackerman, 2012; Daniel, 2014; Poulsen and Spiker, 2014; Stankiewicz, 2017) alter the fact that whether in highly or poorly developed countries food is mostly produced in large tracts of agricultural land, usually located outside urban areas. Therefore, the purpose of this paper is to identify the mutual relationships between agricultural development levels, on one side, and the socioeconomic and natural characteristics of commune (the smallest administrative units in Poland), on the other. In other words, this paper attempts to discover the importance of the communes' general development levels and of natural and structural conditions of farming as determinants of agricultural development measured with the amount of farm investments co-financed by the EU. Metrics of territorial differences in the extent of agricultural investments, social capital, infrastructure, socioeconomic situation and agrarian structure were defined in order to meet that objective. That approach was used because it shows the extent of development (investment) measures and, at the same time, the skillfulness and efficiency in applying for aid funds. There are many papers addressing the internal characteristics of operators who use EU funds in their investments in the context of Polish particularities (Czubak et al., 2010; Czubak, 2013; Czubak et al., 2014). However, there is lack of studies on exogenous factors that make this

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processes differ across the territory. The inclusion of socioeconomic, natural and structural factors is a new approach to research on territorial differences in agricultural investments supported with aid funds. Poland was selected as an example because of the importance of agriculture in its national economy. Next to Romania and Greece, Poland is an EU country with the largest share of labor force employed in the agricultural sector. In 2017, it was 17.4 %, compared to 1.4 % and 2% for the UK and Belgium, respectively (Dybowski et al., 2018). Also, Poland is the largest beneficiary of EU rural development funds. In 2007–2013, more than EUR 13 billion were allocated under the 2nd pillar of the CAP (Poczta et al., 2013; Rural Rural Development in the E.U., 2013). The particularities of the Polish agriculture are also manifested in the fact that the agrarian structure is essentially fragmented and highly heterogeneous across the national territory. This is the consequence of a specific historical process, namely the implementation of three different (Russian, German and Austrian) agricultural policies during the 19th century partitions era, and the territorial rearrangement after World War 2. Large state-owned agricultural holding were established in the western and northern regions (parts of the pre-war German territory); after the economic and political shift, they were transformed into commercial farms. Because of territorial differences in its agrarian structure, Poland is an interesting subject of research on the importance of structural factors in economic processes. Therefore, although the findings from this study are country-specific, they also have a more universal dimension. Obviously, extreme caution needs to be exercised in the interpretation because economic phenomena taking place at a given place and moment in time are largely unique.

2. Importance of agriculture for rural development

Although multifunctional rural development is in progress, agriculture continues to be an important part of the economy which is decisive for the standards of living and for socioeconomic development at local level. Hence, agriculture affects economic development while having a considerable impact on natural and environmental conditions. The importance of agriculture has evolved over the years. Factors that impact agriculture primarily include natural, socioeconomic and institutional conditions (Banks and Marsden, 2000; Wilson and Hart, 2001; Lahmar, 2010; Prager and Posthumus, 2010; Sattler and Nagel, 2010; Zegar, 2010a; Kowalski, 2011; Czubak and Pawłowski, 2020). In rural areas, agriculture determines the key functions and uses of land while also affecting the natural environment and landscape. Through its local economic function, it provides opportunities for socioeconomic development by offering jobs to a large group of rural residents. Undoubtedly, it provides momentum for rural transformation, even though technical progress has considerably reduced the demand for agricultural labor, thus also reducing the economic importance of agriculture. In the most developed countries, both the proportion of agricultural labor and the share of agriculture in macroeconomic indicators (mainly including GDP) is only a few percent. Nevertheless, agriculture delivers food products of strategic importance from the social perspective. Irrespective of technical progress, the production of food requires large areas of land mainly located outside big cities.

Also, agriculture fulfills many other functions of both social and economic nature. In the European Union, an important problem is to determine the importance of agriculture as a sector of the economy which not only produces food and agricultural raw materials but also fulfills a series of other functions (Wilson, 2001; Van der Ploeg and Roep, 2003; Zajac, 2014). Developed to solve that issue, the European Model of Agriculture assumes that in addition to “commercial agriculture” (which is competitive, related to the market and to non-agricultural parts of agribusiness) there is also a “multifunctional agriculture” in charge of delivering market goods (direct sales, processing of agricultural raw materials, non-agricultural economic activity) and non-market goods in the form of landscape values, nature, biodiversity and environmental rebalancing. Rural and agricultural development in

the European Union, including in Poland, continues to be strongly impacted by regional or even local conditions. It takes different forms which largely depend on regional particularities or local (e.g. commune) environments which, in turn, are affected by a series of advantageous or restrictive factors and characteristics (Grosse and Hardt, 2011; Kłodziński, 2012; Czyżewski and Czyżewski, 2013).

When assessing the importance of agriculture to local development, especially in rural areas, bidirectional interactions must be considered: on the one hand, agriculture can transform rural areas by having an impact on landscape or by developing one of its functions which is food production. It also creates jobs, not only in the agricultural sector itself (which needs less and less labor, as mentioned earlier) but also in its business and institutional environment (Mrówczyńska-Kamińska, 2008; Borshchevsky, 2012; Poczta, 2012; Pepliński et al., 2017; Mantino, 2017; Pepliński, 2019). This includes the development of other links of the agribusiness chain, primarily the agri-food processing sector which serves the local market while increasing its role as an exporter (mostly to EU countries) (Mrówczyńska-Kamińska, 2013; Poczta and Rowiński, 2019). Note that a large part of processing plants (as well as producers and distributors of means of production for agriculture) are located either in rural areas or in small towns.

On the other hand, the level and target of local development affect the development capacity of agriculture. One of the trends followed by modern economies is the decline in cost efficiency of agricultural production compared to other sectors (Adamowicz, 2009; Byerlee et al., 2009; Zegar, 2010b; Czyżewski and Poczta-Wajda, 2011; Poczta et al., 2013; Piworowicz, 2015; Czyżewski, 2018). In the context of local development, it often results not only in the relative reduction of economic importance of agriculture but also in reducing the area under crops, sometimes leading to a complete discontinuation. This is especially true in areas located near well-developed big cities where competition for land promotes non-agricultural activities such as industrial, service or land development (suburbanization) activities. Investment decisions made by farmers result from the combined impacts of exogenous and endogenous factors (Rosner, 2011, Minviel, and Latruffe, 2016). The first group includes supply conditions; availability and cost of productive inputs; economic policy, mainly including agricultural, monetary and fiscal policy; inflation rate; interest rate; legal regulation; and demand for raw materials produced. In a more general sense, agricultural development (and the resulting investment capacity) also depends on the development level of a country. In the case of Poland, this mostly means the positive aspects of the transformation that followed the fall of real socialism and the accession to the EU. Factors indicated by Piątkowski (2018) include the radical economic reform in early 1990s, the formation of development support institutions and the high education levels of a large part of the society (inherited from the socialist era). Also, natural and cultural values that condition the development of natural tourism, including agritourism which represents an additional activity of farms, have also mattered in the last decades (Sadowski and Wojcieszak, 2019).

In turn, endogenous factors include the economic and financial situation of farms; sophistication of production techniques employed; degree of wear of fixed assets; knowledge level and age of farm managers. Hence, these factors largely result from the production potential of agriculture. Investment decisions also depend on the farmers' social and human capital levels (Mantino, 2017). According to Wilkin and Nurzyńska (2016), the educational gap between urban and rural areas is gradually reduced. An important aspect in this context are the specific skills needed to apply for aid; this involves a certain effort required to access knowledge on support schemes, prepare the essential documents and, as it is often the case, acquire external capital for pre-financing purposes. Therefore, filing an application strongly depends on the farmers' attitude towards investing and towards the agricultural policy. According to Ingold (2011); Kriesi and Jegen (2001); Simantov (1973), the acceptance of the agricultural policy by the farmers is an essential factor of success in its implementation and a key enabler of

changes to it (Dermont et al., 2017; Minviel and Latruffe, 2016).

3. Characteristics of supporting programs

As a metric of agricultural development, this paper relies on variables related to investment activities of farmers who made investments co-financed with EU funds under the “Modernization of agricultural holdings” and “Setting up of young farmers” schemes in 2007–2013. In Poland, “Modernization of agricultural holdings” was an important measure preparing the farms for the participation in the single market. The support was intended to make farms more competitive through technical upgrades, implementing new technologies that may contribute to farming efficiency, and a better utilization of productive inputs. It has been implemented since 2002 as a basic support tool under SAPARD, the pre-accession program. After the accession, in 2004–2006, it was a major part of the Sectoral Operational Program “Agriculture.” Later, it became a key measure under two subsequent Rural Development Programs (in 2007–2013 and 2014–2020). Since 2002, it has been renamed many times, and the detailed areas of intervention have been changed accordingly. However, its basic assumptions remained unchanged. First of all, no changes were made to the main objective which was to support the modernization of farms exhibiting an adequate production potential, mainly in the form of land resources. In 2007–2013, the period covered by the study on the “Modernization of agricultural holdings” presented below, funds were available to farmers who met specific requirements. These included adequate skills, physical size of the farm (expressed in ha) and the economic surplus calculated as the Standard Gross Margin, a metric used across the entire European Union. Eligible projects include the construction or modernization of buildings and machinery and the establishment or modernization of orchards or permanent plantations. Support is available as a partial refund of investment expenditure. The maximum amount of support granted to one beneficiary during the term of the Rural Development Program could not exceed EUR 76,848.2 (i.e. PLN 300,000).

In turn, the second program of support for modernization investments, which also has been implemented in various forms since before the accession (SAPARD), is the “Setting up of young farmers.” In this case, the main objective was to support people aged up to 40 who started an agricultural activity for the first time and were adequately qualified. In 2007–2013, the beneficiaries were required to spend 70 % of the grant (in the amount of EUR 25,616) on investments, primarily including the purchase of machinery, modernization of buildings, establishment of orchards, and purchase of animals or agricultural land. As an important condition of eligibility for the grant, the farmers were required to acquire a farm with no less than the national average (ca. 10 ha) and no more than 300 ha of agricultural land. The study took account of measures for which financing is no longer available. This provided an opportunity to examine and present the territorial differences in farming investments co-financed by the European Union, illustrated by the example of Poland as a beneficiary of Union funds.

4. Material and methods

The research on mutual relationships between the level of agricultural development and the general characteristics of communes was illustrated by the example of Poland. Therefore, the findings can be extrapolated into other countries only to a limited extent. As a consequence, no general and clear conclusions can be drawn regarding these relationships. This is because the structure of the economic system of different countries does not only depend on general economic principles; it is also strongly affected by historical processes, prevailing market conditions and in the case of agriculture by natural conditions and agricultural structures (mainly including the agrarian structure). Nevertheless, the patterns revealed by analyses can provide grounds for more generalized statements, being an example of possible

relationships between local development and agricultural development targets.

The approach which consists in using the amount of investments as a metric of agricultural development at local level is all the more reasonable since the informed actions taken by individual producers to increase their production potential reflect the development of their farms. Similarly, the intensification of these processes in a commune is indicative of agricultural development at local level. The above is true irrespective of whether or not the investments are supported with public funds. Indeed, it can be assumed that while the amount of certain investments may be overstated due to the involvement of non-refundable external funds, the fact alone of implementing a project results from internal needs of individual operators.

The following was used as metrics of investment activity at commune level:

- amount of investments co-financed under “Modernization...” and “Setting up...” programs (EUR per hectare of agricultural land in a commune),
- amount of investments co-financed under “Modernization...” and “Setting up...” programs (EUR per farm),
- share of farms who made investments co-financed under “Modernization...” and “Setting up...” programs (total number of farms in a commune = 100).

The above takes account of total investments made in different communes throughout the operating period of the 2007–2013 Rural Development Program.

The socioeconomic development level of a commune is a complex and multifaceted aspect which therefore was specified based on three synthetic characteristics referring to the following areas:

- social capital; the following simple characteristics were used (for a complete list of data sources, see Table 1):

x1: foundations, associations and social organizations per 10,000 population of a commune – stimulant;

x2: number of people who used a public library during the last year as a percentage of the commune’s population aged over 10 – stimulant; this variable was selected even though online resources are now available for use. However, not all books can be accessed online. Moreover, the use of libraries is a form of an intentional, measurable cultural activity, and therefore may provide a good indication of social capital levels.

x3: number people in families covered by the social assistance system as a percentage of the commune’s population - destimulant;

Infrastructure and location rent:

x1: average traveling time from the commune to a capital of the region (location rent) – stimulant;

x2: commune population per public pharmacy (social infrastructure) – destimulant;

x3: share of population served by a sewerage network (technical infrastructure) - stimulant;

economy and standards of living:

x1: operators entered to the register of economic activity per 10,000 population of a commune – stimulant;

x2: average income per personal income taxpayer based in the commune – stimulant;

x3: share of unemployed people in the working-age population - destimulant.

The construction of the synthetic characteristic was split into the following stages (Wysocki and Lira, 2005):

- selecting the simple characteristics for the phenomena considered,
- normalizing the values of simple characteristics,
- determining the values of synthetic characteristics.

Table 1
Data sources used in this research.

Field of research	Variables	Data source
Farm investments	Number of farms in communes who made investments co-financed under “Modernization...” and “Setting up...” programs in 2007–2013 Total amount of investments co-financed under “Modernization...” and “Setting up...” programs in 2007–2013	Unpublished data of the Agency for Restructuring and Modernization of Agriculture
Socioeconomic development level of communes	Number of foundations, associations and social organizations Number of library members Number people in families covered by the social assistance system as a percentage of the commune’s population* Average traveling time from the commune to a capital of region* Commune population per public pharmacy Share of population served by a sewerage network Operators entered to the register of economic activity Average income per personal income taxpayer* Share of unemployed people in the working-age population Commune population Commune population aged over 10	Local Data Bank of the Central Statistical Office https://bdl.stat.gov.pl Unpublished data of the Ministry of Family, Labor and Social Policy, after: Stanny et al. (2018) Unpublished data of the Ministry of Agriculture and Rural Development, after: Stanny et al. (2018) Local Data Bank of the Central Statistical Office https://bdl.stat.gov.pl Unpublished data of the Ministry of Finance, after: Stanny et al. (2018) Local Data Bank of the Central Statistical Office https://bdl.stat.gov.pl
Agrarian structure of the commune	Total number of farms Number of farms with an area of over 10 ha	
Natural conditions for agriculture	Quality index of agricultural production space*	Unpublished data of the Institute of Soil Science and Plant Cultivation in Puławy

Source: own study.

* Source data is not listed in Appedix S1 file, because the authors do not have the permission of the owners to publish it.

Simple characteristics (Table 1) were selected based on the following relevant and statistical criteria:

- availability of statistical data at commune level,
- high relevance,
- weak correlation with other characteristics of the same phenomenon (based on the analysis of diagonal entries of the inverse of the R correlation matrix).

The normalization procedure consisted in converting the values of each characteristic to ensure comparability by rescaling them and unifying their orders of magnitude. The following formulas were used for that purpose:

(1) for stimulants:

$$z_{ji} = \frac{x_{ij} - \min\{x_{ij}\}}{i \max\{x_{ij}\} - \min\{x_{ij}\}}$$

(2) for destimulants:

$$z_{ji} = \frac{i \max\{x_{ij}\} - x_{ij}}{i \max\{x_{ij}\} - \min\{x_{ij}\}}$$

where:

x_{ij} ($i = 1, 2, \dots, n; j = 1, 2, \dots, m$) is the value of simple characteristic j in commune i .

The synthetic characteristics of different phenomena were determined using the ideal solution method which consists in calculating the distance of an individual unit from the ideal solution. The distance is calculated as follows, based on the normalized values of characteristics under consideration:

$$(3) q_i^{(2)} = \sqrt{\frac{\sum_{j=1}^m (z_{ij} - z_{0j})^2}{m}}$$

where:

z_{0j} is the normalized value of characteristic j of the ideal solution which is such that:

$$(4) z_{0j} = \max\{z_{ij}\}$$

In the next step, the synthetic characteristic of socioeconomic development at commune level was defined as the arithmetic mean of “social capital,” “infrastructure and location rent” and “economy and standards of living” characteristics.

Agriculture was considered in the context of its natural and anthropogenic conditions (related to the agrarian structure) which prevail in the communes. The following metrics were used for that purpose:

- quality index of agricultural production space (expressed in points) as a natural condition,
- share of farms with an area of over 10 ha (total farms in the commune = 100) as a structural condition.

When it comes to agriculture, no synthetic characteristic was used, first of all because the quality index of agricultural production space itself is of a synthetic nature as it indicates the territorial heterogeneity of natural conditions for agricultural production. It was developed by the Polish Institute of Soil Science and Plant Cultivation as an integrated index based on such diagnostic features as soil quality, climate, land relief and hydrology (Montgomery, 2007; Dudzińska, 2011). The anthropogenic structural conditions of agriculture were presented as the share of farms with an area of over 10 ha; this precludes the use of a synthetic characteristic, all the more so since individual variables related to the agrarian structure are by nature correlated due to mathematical (functional) relationships. The lower threshold of 10 ha was set because it is close to the limit of eligibility for both support programs and to the average farm area in Poland. The variables presented above were used to identify the relationship, if any, between the farmers’ investment activity at commune level and:

- socioeconomic development level of the commune,
- natural conditions for agriculture in the commune,
- local agrarian structure.

Three essential methods were used for that purpose:

- graphic similarity in the territorial distribution patterns of particular phenomena (in the form of a map; each time, the commune is used as the unit); quintile groups of communes were identified for that purpose, with ca. 435 units each.

- identifying the strength of relationships between the implementation of farm investments co-financed by the EU, on one side, and the socioeconomic development level and the condition of agriculture on the other; the Pearson correlation coefficient was used for that purpose,
- creating typological groups of communes based on the share of farms who made investments co-financed under “Modernization...” and “Setting up...” programs; in this case, too, administrative units were divided into quintile groups.

The study covered rural and urban-rural communes. Urban district, a local unit specific to the Polish administrative system, was excluded; this category includes the largest cities where, due to their nature, agriculture either does not exist or plays a negligible role.

5. Empirical results

5.1. Scale of the investment

Nearly 100,000 investments co-financed under the “Modernization...” program and almost 38,000 investments co-financed under the “Setting up...” program were implemented on a countrywide basis over the lifespan of the 2007–2013 Rural Development Program (Table 2). These are relatively small numbers, considering that over 1.5 millions farms with an area of over 1 ha exist in Poland (according to the 2010 Agricultural Census). As a direct consequence of its nature, the “Setting up...” program attracted much less interest than the “Modernization...”. First, it involves much more stringent formal criteria (mainly including age and the requirement to start a farming business) and offers smaller amounts of support. Therefore, both the countrywide average investment value and farm size were greater in the “Modernization...” than in the “Setting up...” program.

Later in this study, the variables relating to both investment support programs were considered jointly. First of all, note that the highest intensity of investment activities (calculated as the share of farms who made investments) was recorded in western, northern-western and, to some extent, in the northern eastern part of Poland. Conversely, the lowest intensity was found in the south east region (Fig. 1).

Table 3 presents the results for communes grouped into quintile classes illustrated in Fig. 1. The intensity parameters of the farmers’ investment activity strongly differ between the classes. There is a nearly eightfold and a 30-fold difference between the first class (up to 2.25 % of investing farmers) and the fifth class (16.68 %–57.52 %) in the amount of investments per hectare in the commune and in the amount of investments per farm located in the commune, respectively.

5.2. The farmers’ investment activity vs. Commune development level

The synthetic characteristics, based on variables described in the methodology section, were used to examine the relationship between the farmers’ investment activity and commune development level. The territorial distribution of the socioeconomic development metric (the mean value of three sub-characteristics) is shown in Fig. 2. Two trends can be observed: first, there is a quite strong relationship with the location rent related to the proximity to capitals of the region which are local or national development centers. The highest development levels

were found in communes located in the immediate vicinity of big cities, primarily including Warsaw, Łódź, Wrocław, Poznań, Krakow and the Silesian agglomeration. Secondly, eastern and southern parts of the country demonstrate much lower levels of development.

However, the territorial heterogeneity of socioeconomic development at commune level, as described above, does not prove to be related to the farmers’ activity in implementing investments co-financed by the EU. Each time, the Pearson correlation coefficients between the variables representing the two processes demonstrate the absence of any relationship. This is true for individual sub-characteristics related to “human capital,” “infrastructure and location rent” and “economy and standards of living” as well as for the averaged characteristic of socioeconomic development (Table 4). Similarly, the values of characteristics in particular quintile groups (Table 5), defined based on the share of investing farms, are at similar levels and usually do not follow any considerable upward or downward trends.

5.3. The farmers’ investment activity vs. Natural and structural characteristics of agriculture at commune level

The relationship between the farmers’ investment activity and the condition of agriculture in different communes was examined in the context of natural conditions (represented by the quality index of agricultural production space) and of anthropogenic conditions (in the form of selected aspects of the agrarian structure). The natural conditions for agricultural production in Poland vary strongly across the national territory (Fig. 3). The best are experienced in the north (near Gdansk), in the south and in the southeast, including in the piedmont of the Carpathians and Sudetes. Note however that these locations (especially when it comes to eastern areas) coincide neither with the distribution of socioeconomic development levels of communes nor with the agrarian structure (as will be discussed later). Once again, this suggests that agriculture develops in an autonomous way and that natural conditions for agricultural development are not necessarily of decisive importance. The above is true even though agriculture by nature depends on the environment. However, that relationship was made less important by technical and organizational progress which can be implemented to various extents depending on the potential of individual farms rather than on natural conditions for production. What is particularly important from the perspective of the purpose of this study is the absence of relationships between the territorial heterogeneity of the quality of agricultural production space and the farmers’ investment activity in different communes. Correlation coefficients suggest a weak relationship (Table 6). In the context of the typology used in this study, the mean index grows from one class to another but the differences are relatively small (Table 7).

A strict relationship exists only between the territorial heterogeneity of the farmers’ investment activity and the agrarian structure. High and positive (> 0.5) correlation coefficients are observed between the investment amount per farm in the commune, and between the share of investing farms and the share of farms with an area of over 10 ha (Table 6). A slightly weaker relationship (0.409) was recorded for the amount of investments per hectare. Similarly, in subsequent quintile groups (Table 7), the different characteristics of the agrarian structure grow consistently from 18 % in the class 0–0.25 % to over 70 % in the class > 16.68 %. From the geographic perspective, the highest share of farms with an area of over 10 ha (Fig. 4) is found in communes of

Table 2

Investments co-financed under “Modernization of agricultural holdings” and “Setting up of young farmers” programs on a countrywide basis.

Measure	Number of farms	Average farm area (hectares of agricultural land per farm)	Average investment value (EUR per farm)
“Modernization...”	97,929	48.4	100,759
“Setting up...”	38,727	17.2	22,565

Source: own calculations based on <https://bdl.stat.gov.pl> and on unpublished data of the Agency for Restructuring and Modernization of Agriculture.

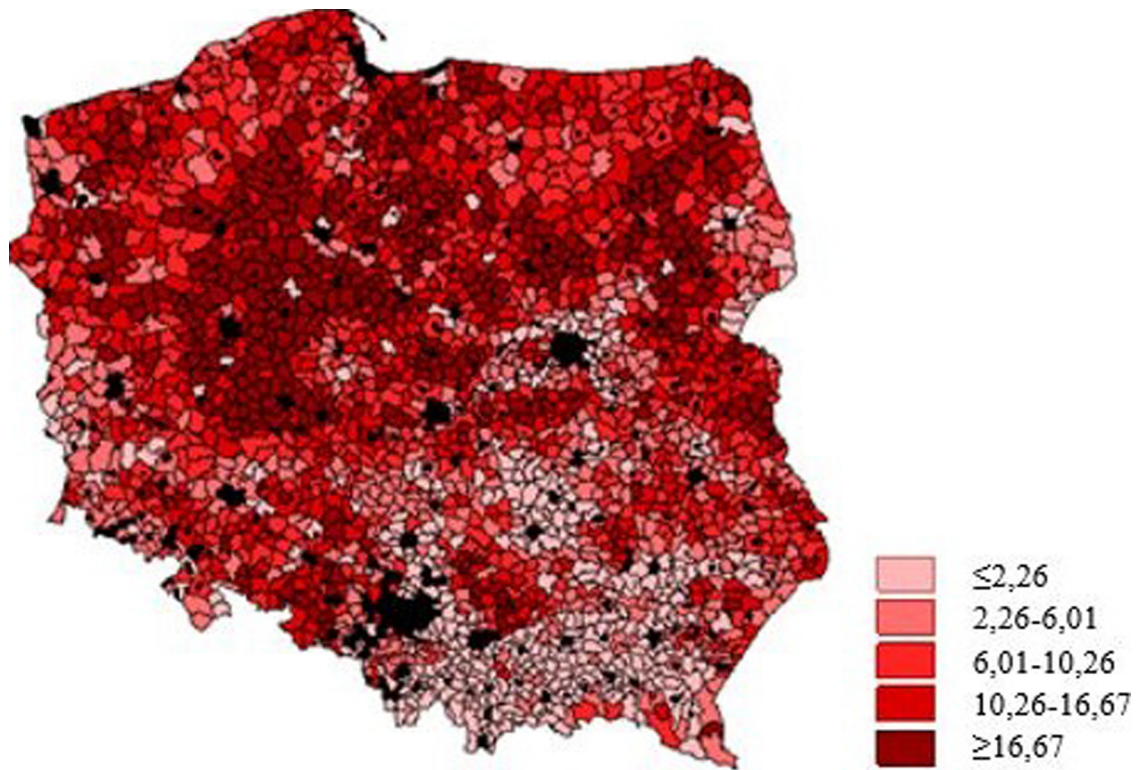


Fig. 1. Share of Polish farms which made investments co-financed by the EU. Source: own calculations based on <https://bdl.stat.gov.pl> and on unpublished data of the Agency for Restructuring and Modernization of Agriculture

western and northern Poland: from regions of Zachodniopomorskie and Wielkopolskie, through to Kujawsko-Pomorskie, Warmińsko-Mazurskie, northern Mazowieckie and northern Podlaskie. The smallest numbers of farms with an area of over 10 ha are located in southeast Poland. The investment activity map (Fig. 1) is quite similar.

6. Discussion

Findings from this research reveal different determinants of local and agricultural development. In the first case, the most important factor was the location, which confirms the previous research in this area (Czyż, 2012; Bański, 2013; Trojak, 2013). The territorial heterogeneity of the process under consideration, including the dominant importance of big cities, is driven by spontaneous market principles which in most highly and medium developed capitalist countries are corrected through a targeted regional policy (Combes et al., 2008; Domański, 2008; Kunzmann, 2010; Phelps et al., 2010; Fujita, 2011; McGuirk, 2011).

In the case of spatial differentiation of agricultural development,

other characteristics are decisive. Examined investment activity, as a metric of agricultural development, is related neither to the location rent (due to the proximity of big cities) nor to other aspects of the geographical heterogeneity of Polish communes. Li et al. (2019) even noted that rural development, especially in developed countries, should be based on the formation of social capital rather than on agricultural production. This suggests that agriculture develops in an autonomous way, in isolation from general development trends. This may be caused by several reasons related to the particularities of agricultural production. First, agriculture requires much space; therefore, today, the proximity of big cities is a barrier rather than an advantage. Second, agriculture produces raw materials intended for further processing and can be therefore located far away from final customers in the marketing chain who largely live in urban areas, including in big metropolises. Also, the development of vehicles and cooling systems made it possible to extend the physical (geographic) distance between the place where agricultural raw materials are produced and the target location where food products are consumed. Another important aspect is the immobility of land and the poor mobility of the farming labor force. Being

Table 3

Projects implemented at commune level, grouped by the share of farms who made investments co-financed under “Modernization of agricultural holdings” and “Setting up of young farmers” programs.

Communes grouped by the share of farms who made investments co-financed under “Modernization...” and “Setting up...” programs	Number of communes*	Amount of investments co-financed by the EU (EUR per hectare of agricultural land in the commune)	Amount of investments co-financed by the EU (EUR per farm in the commune)	Share of farms who made investments co-financed by the EU (total farms = 100)
0 – 2.25%	437	159	720	1.0
2.26 – 6.01%	433	418	3124	4.2
6.02 – 10.26%	435	617	6470	8.1
10.27 – 16.67%	435	840	11,051	13.2
16.68 – 57.52%	433	1257	20,944	24.0
Total	2173	658	8448	10.1

Source: own calculations based on <https://bdl.stat.gov.pl> and on unpublished data of the Agency for Restructuring and Modernization of Agriculture.

*The reason behind the small differences in the number of communes distributed between the quintiles is that some of them had the same share of investing farms.

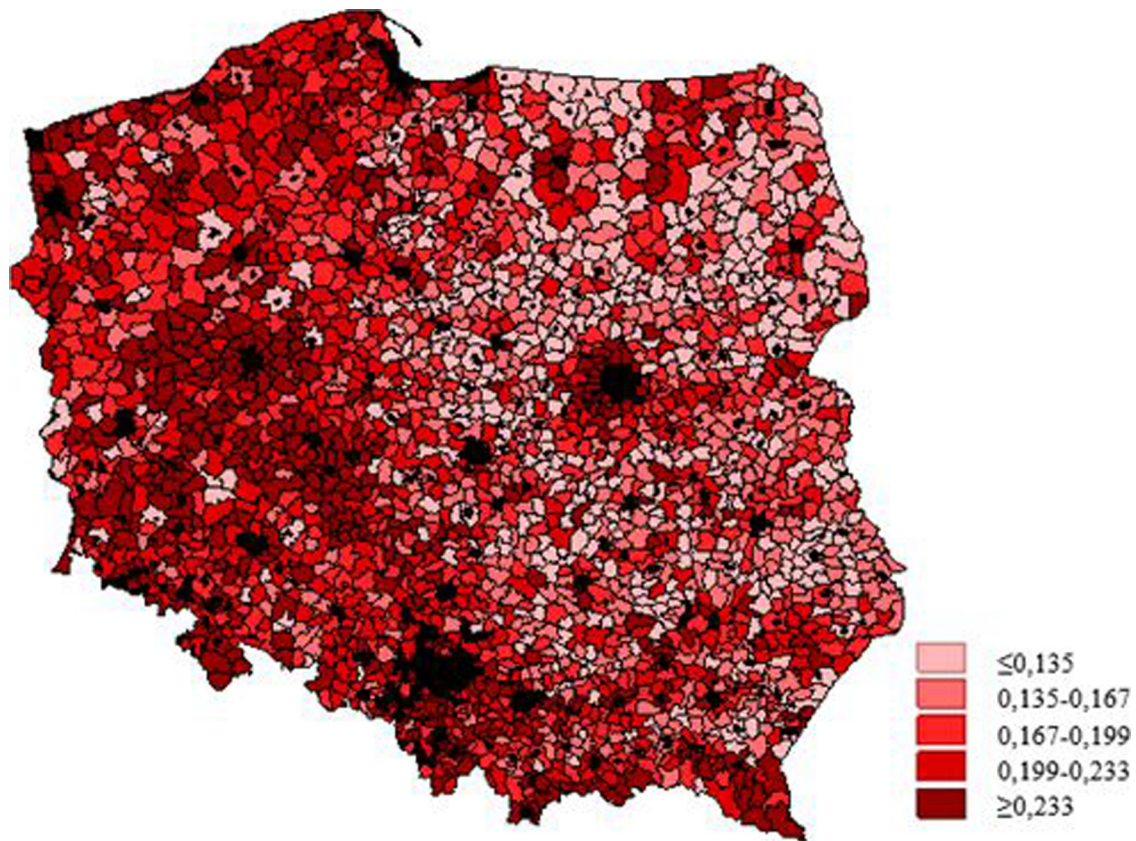


Fig. 2. Synthetic indicator of socioeconomic development of Polish communes.

Source: own calculations based on <https://bdl.stat.gov.pl>, unpublished data of the Agency for Restructuring and Modernization of Agriculture and Stanny et al. (2018)

Table 4

Strength of relationships between the implementation of farm investments co-financed by the EU and characteristics of communes (Pearson correlation coefficient).

Variable	Amount of investments co-financed by the EU (EUR per hectare of agricultural land in the commune)	Amount of investments co-financed by the EU (EUR per farm in the commune)	Share of farms who made investments co-financed by the EU (total farms = 100)
Hellwig development index for “social capital”	− 0.001	− 0.007	− 0.022
Hellwig development index for “infrastructure and location rent”	− 0.049	− 0.001	− 0.083
Hellwig development index for “economy and standards of living”	− 0.021	− 0.017	− 0.136
Mean indicator of socioeconomic development	− 0.039	− 0.012	− 0.126

Source: own calculations based on <https://bdl.stat.gov.pl>, unpublished data of the Agency for Restructuring and Modernization of Agriculture and Stanny et al. (2018).

Table 5

Synthetic characteristics of commune development grouped by the share of farms who made investments co-financed under “Modernization of agricultural holdings” and “Setting up of young farmers” programs.

Communes grouped by the share of farms who made investments co-financed under “Modernization...” and “Setting up...” programs	Hellwig development index for “social capital”	Hellwig development index for “infrastructure and location rent”	Hellwig development index for “economy and standards of living”	Mean indicator of socioeconomic development
0 – 2.25%	0.17	0.23	0.20	0.20
2.26 – 6.01%	0.18	0.20	0.19	0.19
6.02 – 10.26%	0.17	0.21	0.17	0.18
10.27 – 16.67%	0.16	0.20	0.17	0.18
16.68 – 57.52%	0.17	0.19	0.16	0.17
Total	0.17	0.21	0.18	0.18

Source: own calculations based on <https://bdl.stat.gov.pl>, unpublished data of the Agency for Restructuring and Modernization of Agriculture and Stanny et al. (2018).

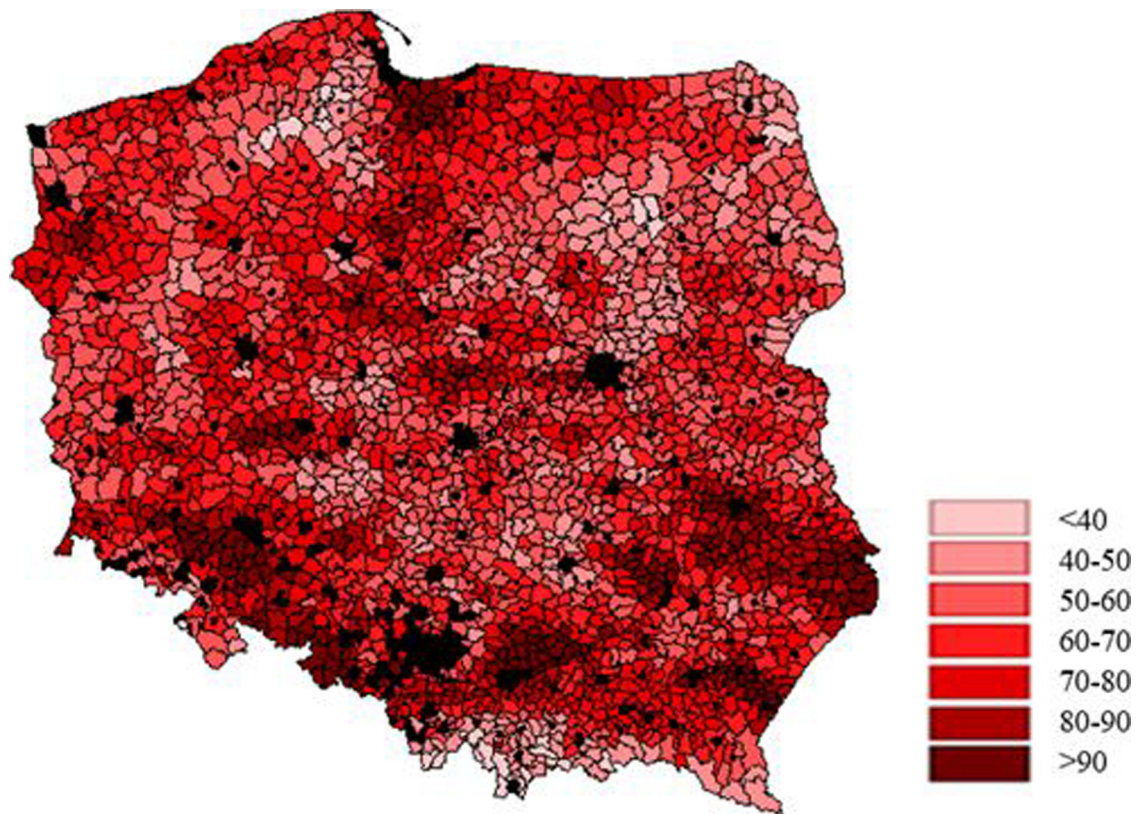


Fig. 3. Quality index of agricultural production space in Poland (score).
Source: unpublished data of the Institute of Soil Science and Plant Cultivation

a holder, and especially an owner, of agricultural land is largely determinant for the nature of one's economic activity. This is especially true for large farms. Conversely, it is easier for non-users of agricultural land to decide to migrate from a less developed to a more developed region, whether located in their country or abroad. Therefore, at local level, agriculture develops autonomously and is not affected by general trends, including multifunctional rural development.

The findings from conducted analyses somehow contradict the von Thünen's classic theory of rational land use, including the location of agricultural holdings. According to theory of rings, more efficient production lines are located closer to big city markets. Von Thünen focused his research on the impact of transport costs on land rent and claimed that as the distance between land and an urban center increases, land rent declines; this has an impact on the location of production plants (O'Kelly and Bryan, 1996; Kundera, 2004; Grigg, 2005). Therefore, it may be concluded that as the distance from an urban center increases, the intensity of agriculture declines, and so does cost efficiency at farm level. In his theory, von Thünen demonstrated the existence of rings of intensity. Intensive agriculture and horticulture were located the closest to cities. The second ring is forestry and leisure

functions whereas the third one represents extensive agriculture (Van der Venn and Otter, 2001; Fujita, 2011). Note however that the von Thünen's concept was developed in the 19th century when the options for transport and storage of agricultural raw materials differed considerably from what is available today. This is especially true for perishable products which now can be stored for long periods and transported over large distances without the risk of quality loss. Hence, as shown in this study, the distance from large urban centers proved not to be important from the perspective of the farmers' investment activity. Moreover, in the context of pig production in Poland (which is a quite intensive production sub-sector), Pepliński (2019) noted that concentration processes took place in peripheral and sub-peripheral areas which is related to nuisances it causes to the population. This also suggests that the general human progress which affects agriculture and its environment redefines the territorial heterogeneity of agricultural production, and requires a critical review of today's applicability of the von Thünen's ring theory in its classic version (Van der Venn and Otter, 2001; Pinto-Correia and Breman, 2008; Thieme, 2010; Fujita, 2011). What also matters is the fact that the absence of a relationship between the broadly defined socioeconomic development and agricultural

Table 6

Strength of relationships between the implementation of farm investments co-financed by the EU and agricultural characteristics of commune (Pearson correlation coefficient).

Variable	Amount of investments co-financed by the EU (EUR per hectare of agricultural land in the commune)	Amount of investments co-financed by the EU (EUR per farm in the commune)	Share of farms who made investments co-financed by the EU (total farms = 100)
Quality index of agricultural production space (score)	0.058	0.058	0.204
Share of farms with an area of over 10 ha (total farms in the commune = 100)	0.105	0.159	0.715

Source: own calculations based on www.stat.gov.pl and on unpublished data of the Agency for Restructuring and Modernization of Agriculture.

Table 7

Agricultural characteristics of communes grouped by the share of farms who made investments co-financed under “Modernization of agricultural holdings” and “Setting up of young farmers” programs.

Communes grouped by the share of farms who made investments co-financed under “Modernization...” and “Setting up...” programs	Quality index of agricultural production space (score)	Share of farms with an area of over 10 ha (total farms in the commune = 100)
0 – 2.25%	60.5	18.0
2.26 – 6.01%	64.6	38.9
6.02 – 10.26%	65.7	52.3
10.27 – 16.67%	68.2	60.7
16.68 – 57.52%	70.2	70.1
Total	65.8	45.8

Source: own calculations based on www.stat.gov.pl and on unpublished data of the Agency for Restructuring and Modernization of Agriculture.

development is observed at local rather than at national level. Research carried out in countries around the world (Tomczak, 2000; Brooks, 2010; Sadowski et al., 2012; Czubak, 2013; Tocco et al., 2013; Pogorzelski, 2014) reveals a strict relationship between the development level and the condition of agriculture. This is the consequence of labor force moving to non-agricultural sectors and of substituting labor with capital in high and medium developed countries. The absence of that relationship at local level can result from the fact that a difference exists between local and national drivers of development. The agrarian structure proves to be more important than the ability to create non-agricultural jobs.

Supported with Union funds, the farms’ investment activity is intense in regions with a dominant share of eligible operators which are large enough to cost-efficiently absorb support funds and use them for farm modernization purposes. Obviously, this could result only from political and legal regulations, i.e. pre-established limits for access. According to this interpretation, investment activity is intense in areas with a large share of eligible operators. Clearly, in a sense, this is the right approach: communes with a dominant share of small farms cannot

have high activity rates due to formal restrictions of access. Nevertheless, the microeconomic rationale behind development investments needs to be considered. Small farms without enough production potential in the form of land resources are unable to make efficient use of investment targets. The use of non-refundable support could (at least potentially) relax the rigidity of the microeconomic assessment of investment efficiency because the investment risk is partially transferred to taxpayers (Sadowski and Wojcieszak, 2019). However, public support does not cover the entire investment expenditure. Therefore, investing farmers bear the risk of failing in their projects; when calculating that risk, they consider (though often without realizing it) the relationship between land and capital resources. This is similar for banks who provide investment capital. The expenditure is partially financed with public funds which lowers the risk score of the investment but does not reduce it entirely. This means that Union support in the form of partially non-refundable co-financing of development measures could contribute to irrational investment decisions (in practice, overinvestment). However, the extent of this process is limited by formal requirements, on the one hand, and by

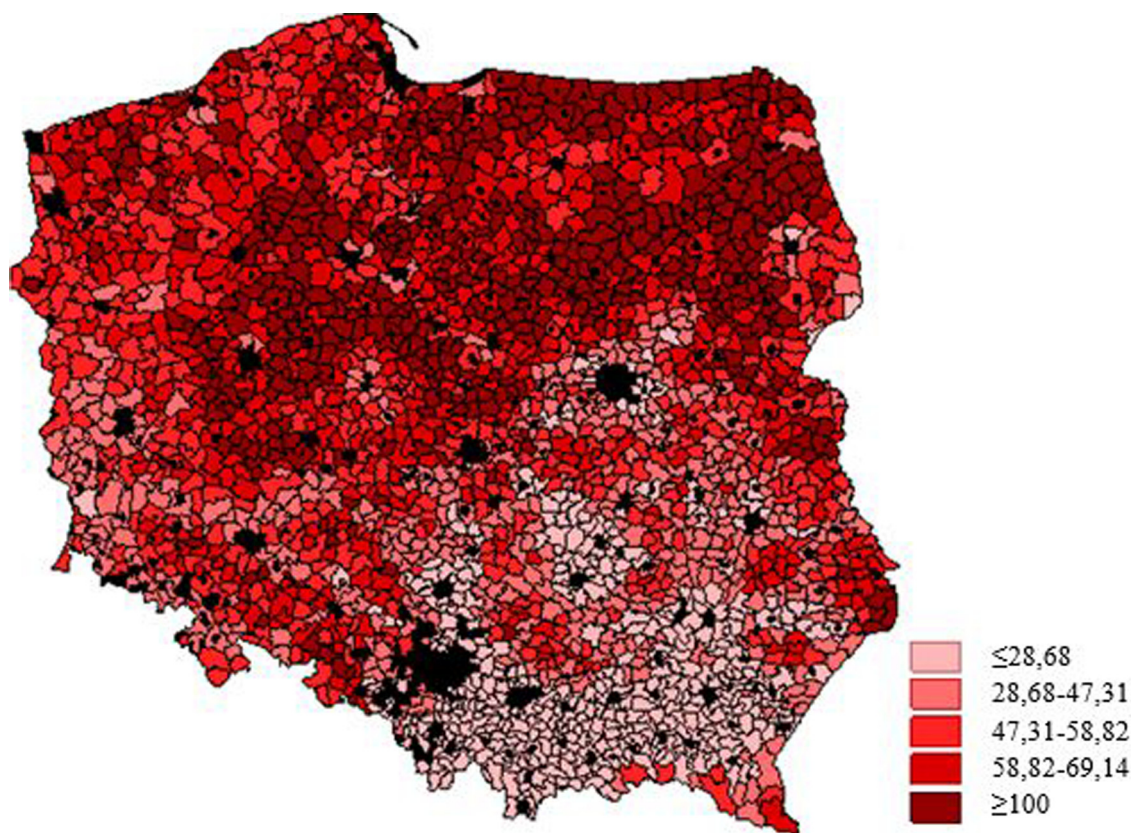


Fig. 4. Share of farms with an area of over 10 ha in Polish communes (total farms = 100).

Source: own calculations based on <https://bdl.stat.gov.pl>

microeconomic calculations, on the other. In this context, note that the agrarian structure which plays an essential role in the territorial heterogeneity of agricultural development measured as the intensity of investment activities at commune level is of an anthropogenic origin (unlike natural conditions), was structured in a historical process and, as an essential characteristic, is largely inertial (Swinnen, 1997; Zegar, 2012; Markuszewska, 2015; Czyżewski and Czyżewski, 2016; Wilkin, 2019). Note also the particularities of Polish agriculture (Halamska et al., 2003). In the 19th century, when the modern agrarian structure was shaped, Poland did not exist as a country. Today's Polish territory was shared between three partitioning powers (Russia, Austria and Germany) and was subject to three different agricultural and regional policies. Nowadays, these historical processes are reflected by a strong territorial heterogeneity of the Polish agrarian structure. The differences continue to this day even though the national territory has been progressively unified in economic terms over the last 100 years or so, and despite the economic and social transition towards concentration of agricultural production (Zegar, 2012; Kiryluk-Dryjska et al., 2018; Halamska et al., 2019). As mentioned by Trojak (2013), the impacts of the partition era continue to be noticeable in other sectors, too. The historical interpretation of phenomena involved in the relationship between the agrarian structure and investment activity, as described above, only partially explains the nature of these phenomena. The entire territory incorporated into Germany, i.e. western Poland, generally demonstrates a large share of farms with an area of over 10 ha. However, that share is also quite high in the northeast (covered by the Russian partition in the 19th century). The most fragmented structure (and the weakest investment activity) is found in the southeast, a territory which was incorporated into either Russia or Austria.

The existence of a relationship between a favorable agrarian structure and farm-level investment activity is confirmed in research conducted both in Poland and in other European countries. Upite (2009) indicated that Latvian investment support measures are focused on large farms, especially including those specializing in cereal cropping. In turn, Olsen and Lund (2009, 2011) used the example of Danish agriculture to demonstrate that investment decision-making is impacted by factors such as farm size and number of years of agricultural activity (the shorter the farming experience, the greater the propensity to invest). They also found that younger farmers invest to create an attractive workplace whereas older farmers do so due to environmental aspects or regulations. When conducting their research in eight EU countries, Viaggi et al. (2011) noted that the following factors emerge as the determinants of farm-level investment growth: specialization, having a successor, farmer's age, labor management, single farm payment per hectare, and location. Andrade et al. (2019) emphasized that investment implementation is mainly determined by a production technology designed to increase productivity.

According to Sin and Nowak (2014) who analyzed the implementation of the "Farm modernization" measure under the RDP in Poland and Romania, it would be possible to increase both the number of beneficiaries of EU funds and the number of farm investments if support was allocated on a per-region basis and if the maximum acceptable project value was reduced. Also, according to Sbarcea (2009), the Romanian post-2005 experience shows that the absorption of Union funds can be ensured if the government subsidizes the interest on loans granted by commercial banks in order to co-finance eligible investments. As indicated by Arion et al. (2012), over the recent years, Romania has seen an improvement in farm structure due to Union funds which narrow the gap between farms through an appropriate agricultural policy that promotes farm restructuring. Smutka et al. (2014) emphasized that the number of active farmers and the farms' initial capital reflect their capacity to access EU funds. They also concluded (in consonance with this paper) that the farmers' activity in accessing Union investment funds differs between regions (countries). The farmers' propensity to invest is related to the output level, territorial structure and levels of technical and social infrastructure. Mantino

(2017) pointed out that in Italy, farm investment support provides better results in terms of job generation; however, it is important to adequately educate the farmers on how to access EU funds. It was also emphasized that there is a need for a more flexible application of the CAP so as to make it capable of addressing diverse territorial needs, and that the CAP should be reinforced with principles for designing and implementing a policy which is more committed to territorial coherence.

The literature on other EU countries, as listed above, can be only partly be compared to the findings of this study. This is because, on the one hand, these research projects differ in scope and methodology and, on the other, certain development processes are unique and specific to a location and point in time. Nevertheless, there is one noticeable convergence which suggests that these findings can be cautiously extrapolated beyond a local scale. Namely, investments (including those financed with EU funds) are implemented by larger and economically stronger farms. As regards territorial differences in investment levels, the greatest intensity of agricultural investments should be expected in regions with a concentrated agrarian structure. Similar conclusions were also drawn by Andersson et al. (2017) and García-Arias et al. (2015).

7. Conclusion

This study focused on interdependencies between socioeconomic, natural and structural characteristics of Polish communes, and the extent of investments supported with EU funds. They revealed that agricultural development processes at local level are autonomous to a certain extent. The highest levels of socioeconomic development of communes was recorded mostly in the western part of the country and near the biggest cities. In turn, the agricultural production space indicator reached the highest levels in selected communes of the north, southeast and south parts of the country. Conversely, the prevalence of large farms with an area of over 10 ha was characteristic of communes located in western and northern Poland. The intensity of investment activities undertaken by the producers based in different communes proved to be generally independent from their wealth and availability of infrastructure. The distance from big cities which are regional and national development centers also proved not to be important. Correlation coefficients between the characteristics of the commune development level and the investment scale were below ± 0.2 in each case. This can be explained by the fact that production is based on raw materials and does not require the physical presence of the end customer but does require large areas of land. Conversely, a strict relationship was discovered between the investment activity and the existing agrarian structure which, in this paper, was represented by the share of farms with an area of over 10 ha. In this case, the relevant correlation coefficients were much greater than 0.5. In the context of Polish realities, similar conclusions were drawn by Kiryluk-Dryjska (2012); Sadowski and Girzycka (2012); Czubak and Sadowski (2014); Adamowicz and Szepeluk (2016); Grontkowska et al. (2016); Wojewodzic (2016); Biczowski (2019) and Kiryluk-Dryjska et al. (2020). According to them, Union funds allocated to investment support are mostly accessed by large farms with a considerable production potential. That relationship explicitly refers to the general pattern of agricultural development which prevailed after the industrial revolution. It consists in the successive emergence of production concentration, specialization and commercialization processes driven by technical progress in agriculture itself and by the development of non-agricultural activities (Czyżewski, 2018). An increase in the farms' capital resources reduces demand for labor, and results in labor being substituted by capital; jobs offered in the industrial and service sectors push the least efficient producers out of agriculture and provide the others with an opportunity to increase their acreage. That process in itself is both spontaneous and essentially positive, although excessive concentration is often criticized from an environmentalist perspective

(Zegar, 2012; Tocco et al., 2013).

In a real-world economy, the consequences of general objective patterns of socioeconomic development are adjusted by local conditions resulting from natural circumstances (e.g. climate, topography) and from the economic and political history. While avoiding excessive generalization, the conclusion with respect to the Polish realities in the 21st century is that the territorial distribution of the farmers' investment activity is largely consistent and statistically correlated with the share of slightly larger farms which are formally eligible for support programs and are able to implement economically sound development investments. Another finding is that the agrarian structure has remained stable for more than a century, which largely results from the three political systems imposed in the 19th century. This, in turn, translates into today's decisions of operators while having an impact on agricultural development at a local level. Indeed, the consequence of a fragmented agrarian structure is the absence of investments and, ultimately, a development barrier both to individual farms and to the entire agricultural sector. This is particularly evident in northeast Poland. While this study revealed the absence of any relationship between investment activities and socioeconomic development at local level, communes located in that part of the country demonstrate a relatively low level of socioeconomic development in addition to having a fragmented agrarian structure. A large part of the country faces compounded problems with local development; this poses a big challenge to the Polish and Union agricultural and regional policies. As demonstrated in this paper, an improved agrarian structure promoted the increase in intensity of the farmers' investment activity while also strengthening the competitive position of both individual farms and communes which were home to a sufficient number of investing farms. On the one hand, from the perspective of development outlooks, it is reasonable to strengthen more competitive operators. However, this is contrary to the requirements of the agricultural (and regional) policy which is intended to make development a convergent (rather than a divergent) process. That problem would be negligible if regional specialization processes were put in place (if functional types of administrative units emerged) to ensure economic development. This is the case in the northeast part of the country where the general levels of socioeconomic development are relatively low but the farmers' investment activity (and the share of the largest farms) is quite high. In these regions, agriculture and the related agribusiness sub-sectors could provide momentum for the local economy. However, problems grow bigger in such regions as southeast Poland where the levels of both agricultural and non-agricultural activity are low.

CRedit authorship contribution statement

Arkadiusz Sadowski: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing - original draft, Supervision. **Monika Małgorzata Wojcieszak-Zbierska:** Conceptualization, Validation, Resources, Writing - original draft, Writing - review & editing. **Patrycja Beba:** Conceptualization, Resources, Writing - original draft, Writing - review & editing.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.landusepol.2020.104934>.

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