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(work in progress, the first draft)

Spillover effects of Cohesion Policy and the Common Agricultural Policy in Poland. A spatial panel data analysis in 2004–2018

Abstract

The study aims to investigate the existence of spatial effects of Cohesion Policy and the Common Agricultural Policy in Poland. A balanced panel of 73 Polish NUTS 3 subregions is used with data for 2004 through 2018. Considering the existing regional stratification in Poland, estimates cover three samples of data: All subregions, Western Poland, and Eastern Poland subregions. Then I test two scenarios for each data sample. The first specification takes into account the value of structural funds, while the second specification covers the coupled value of structural funds and CAP subsidies. To verify spatial effects of financial support under the Cohesion Policy and Common Agricultural Policy, I resort to spatial panel data models that capture not only the direct relationship between European Union policies and economic growth but also spillover effects associated with the externalities from surrounding areas. The results obtained vary depending on the data sample. In general, they indicate a positive impact of European Union policies on growth in Polish NUTS 3 subregions. Moreover, these policies' local spillover effects have been proven. However, econometric analysis finds no statistically significant evidence for global spillover effects. The results are robust to specifications relying on cross-sectional data.

Keywords: Cohesion Policy, Common Agricultural Policy, spillover effects, regional disparities, Poland.

JEL Classification: R11, R12, R58.

1 INTRODUCTION

Despite an active Cohesion Policy (CP) (also known as regional policy), the European Union (EU) continues to suffer from serious regional disparities. Over the past eighteen years, convergence between countries has slowed down and within-country disparities have increased (Pina and Sicari, 2021). Regional stratification is a serious problem for the EU. It not only hinders economic and social cohesion, but also fuels social discontent, creates favorable conditions for social tensions and anti-integration political movements, and provokes selective, unwanted migration (Becker et al., 2017; Esteban and Ray 2011; Granato et al., 2015; Rodríguez-Pose, 2018).

CP was mentioned in the Treaty of Rome in 1957, but particular attention it gained in 1975 with the launch of the European Regional Development Fund (ERDF). Over the years structural funds, the main operational instruments of CP, have constituted the main tool at the disposal of the member states in the fight against regional stratification. From the first financial perspective, 1989-1993 CP was subjected to several reforms that defined the set of new objectives and programs. The distinctive feature of CP is its growing share in the EU budget from 25.5% in 1989-1993 to 33% in 2014-2020 (EUR 336 billion) (European Commission, 2014; European Communities, 2000).

In the EU the development of regions is also supported by the Common Agricultural Policy (CAP). The two-pillar structure of the CAP enhances agriculture production. Pillar one concerns direct payments while pillar two aims to promote the development of rural areas. Contrary to CP, successive EU budgets limited financial resources for the CAP from 53.1% in 1989-1993 to 37.7% in 2014-2020 (European Communities, 2000; European Council, 2013). However, notwithstanding that, the CAP has reminded the most expensive common policy of the EU. The main difference between the two policies lies in their territorial dimension. CP is focused on less developed areas while the CAP subsidies present more sectoral focus.

Poland joined the EU in 2004 with a GDP per capita at 51% of the EU average. At that time none of Polish NUTS 2 regions exceeded 75% of the EU average and were categorized as less developed areas. Moreover, in the group of the five poorest regions of the UE, four of them, Lubelskie (37%), Podkarpackie (37%), Podlaskie (38%), Świętkrzyskie (41%), were located in Eastern Poland (Eurostat). As a relatively large country with significant regional disparities and a low level of social and economic development, Poland has become the largest recipient of CP. In the two financial perspectives, 2007-2013 and 2014-2020 the EU allocated EUR 67.2 and 77.6 billion to Poland, respectively (Eurostat).

Poland's accession to the EU was also associated with participation in CAP subsidies. In 2004, the share of agriculture in the national GAV (gross value added) in Poland (4.1%) was twice as high as in the EU (2.0%) (Ameco). Moreover, the difference in employment in agriculture between Poland (13.3%) and the EU (5.2%) was 8.1. p.p. (Eurostat). Even when comparing the above values, it reveals the lower agricultural productivity in Poland than in the EU. The important role of agriculture ensured a significant inflow of CAP subsidies for the Polish economy. Only in the years 2014-2020, the CAP allocated EUR 32.5 billion for Poland, which was the highest support in the EU (FADM).

Against this background, it is justified to verify the effects of the EU policies in the largest recipient country. The novelty of the study is twofold. Firstly, the article postulates that the financial resources of CP and the CAP should be considered jointly. Both policies often operate in the same geographic area and their financial resources overlap. Regions with agricultural specialization belong to the less developed areas and suffer from an unfavorable structure dominated by agriculture Cappelen et al. (2003). The econometric analysis is conducted for two scenarios. In the first one, the regressor of structural funds covers only the financial resources of CP, while in the second scenario, the regressor that enters the models covers the coupled amount of CP and the CAP. Secondly, being aware of the spatial correlation of economic activity in Poland (poorer eastern regions), I use the spatial panel data approach. This specification not only tracks the relationship between EU policies and economic growth but also shows spatial effects (spill-over effects) of this support. The article fills the gap in the scientific literature regarding the effectiveness of CP in Poland. To the best of the author's knowledge, this is the first empirical attempt to evaluate the spatial effects (spill-over effects) of CP and CAP subsidies in Polish NUTS 3 subregions[i].

The article is organized as follows. After the introduction, part II provides a concise literature review on the subject. Chapter III describes the distribution of structural funds and CAP subsidies in NUTS 3 subregions in Poland. Chapter IV contains an empirical analysis. The study ends with conclusions and a discussion.

2 LITERATURE REVIEW

Economic literature assessing the impact of CP on convergence and growth abounds. The results, however, lead to ambiguous conclusions. Recent studies are more optimistic and highlight a positive impact of structural funds in combating regional stratification (Cerqua & Pellegrini, 2017; Di Caro and Fratesi, 2021; Di Cataldo, 2017; Fiaschi et al., 2017; Giua, 2017; Maynou et al., 2014). Previous studies, rather pessimistic, have highlighted a negative or statistically insignificant relationship between CP and growth or convergence (Bähr, 2008; Ederveen et al., 2006; Esposti & Bussoletti, 2008; Le Gallo et al., 2011; Rodríguez-Pose & Novak, 2013).

Some papers explain why the results are inconclusive. Authors underline that the empirical analysis relies on a different methodology, sample size, or period and ignores some important factors influencing regional growth such as spill-over effects (Pieńkowski and Berkowitz, 2015; Hagen and Mohl, 2009; Marzinotto, 2012). This argument is in line with empirical results showing a stronger impact of CP in Objective 1 regions and more recent data samples (Dall'Erba and Fang, 2015), in regions with a less developed service sector (Percoco, 2017) or in rural areas situated next to the city (Gagliardi and Percoco, 2017).

Some papers have shifted away from the main focus from the overall effects of CP and pay special attention to factors that guarantee its higher effectiveness i.e. human capital and good institutions (Becker et al., 2013), quality of governments (Rodríguez-Pose and Garcilazo, 2015), presence of territorial capital in the regions (Fratesi and Perucca, 2014) or administrative capacity (Surubaru, 2017).

The authors also explore the effectiveness of CP by introducing the spatial interaction between adjacent areas. However, again conclusions are far from consensus. Crescenzi and Giua (2020) prove that the positive effects of CP differ from country to country and are concentrated In Germany or UK, while the effects in southern countries i.e. Italy and Spain were limited by the Great Recession. In turn, Antunes et al. (2020) show that the spatial effects of structural funds do not occur between NUTS 2 regions.

Few of the papers cover both CP and CAP subsidies in the empirical analysis. Montresor et al. (2011) including spatial effects in the β-convergence model confirmed a positive impact of the CAP and CP on labor productivity growth and convergence in 204 NUTS 2 regions of the EU-15. Esposti (2007) applying the GMM panel data specification proved that Objective 1 funds had a positive impact on convergence in the group of 206 regions in 1989-2000. The influence of CAP subsidies did not have a counter-treatment effect on convergence but their impact on growth was very weak.

Papers regarding the effectiveness of Cohesion Policy in Poland show its rather limited but positive impact. Czudec et al. (2019) using dynamic panel data models highlight that CP allowed reducing the regional transport accessibility gap between eastern regions, but at the same time, the innovation gap increased. Lewandowska et al. (2015) based their research on the computer-assisted telephone interview. Relying on the data of the small and medium-sized enterprises they showed that structural funds did not have a positive impact on a commitment to investment. In addition, the econometric analysis based on panel models found a positive relationship between structural funds and regional growth in NUTS 2 regions but the impact of CP on convergence turned out to be insignificant (Piętak, 2021). Finally, Biedka et al. (2021) applying the spatial panel model have shown that investment in human capital co-financed by CP has a positive effect on local revenues in Polish municipalities.

3 DISTRIBUTION OF STRUCTURAL FUNDS AND CAP SUBSIDIES IN POLAND

The administrative reform in Poland of 1999 created 16 *voivodeships* (NUTS 2 regions), 380 powiats (counties), including 65 cities with powiat status, and about 2,500 gminas (communes). Poland is also divided into NUTS 3 subregions. However, this breakdown does not coincide with the administrative division but is necessary to compile comparable data within the EU. After the revision of the NUTS classification in Poland as of 1 January 2018 there are 17 NUTS 2 regions. The Mazowieckie region, characterized by the highest per capita income in the country, was divided into the Warszawski Stoleczny and Mazowiecki Regionalny regions. Moreover, the new division created 77 NUTS 3 subregions (Statistics Poland).

Figure 1 depicts the division of Poland at the NUTS 3 level. Besides, the map is broken down into two parts: western and eastern Poland. The poorer Eastern Poland consists of 5 NUTS 2 regions i.e. Warminsko-Mazurskie, Podlaskie, Lubelskie, Swietokrzyskie and Podkarpackie and covers 16 NUTS 3 subregions, while the remining 57 NUTS 3 subregions belong to Western Poland (12 NUTS 2 regions).

Eastern Poland constitutes the poorer part of the country, the "poor western wall". In 2019, the GDP per capita of all NUTS 2 regions of Eastern Poland was lower than 73% of the national average (Statistics Poland). Moreover, the statistical analysis confirms the declining contribution of these areas to the national GDP, employment, and population (Piętak, 2021b). Also, the gross value added (GVA) obtained in agriculture in the Podlaskie (7.1%), Lubelskie (5.6%) and Warminsko-Mazurskie (5.6%) regions was higher than the national average (2.6%) and it exceeds 5%. It is to stress that one of the operational programs, namely the Operational Programme Eastern Poland, provides support for Eastern Poland's regions aimed at increasing the competitiveness and innovation of this area. In 2021-2017 the program's budget amounts to EUR 2.5 billion.

Place FIGURE 1

Poland joined the EU in 2004 and, representing large regional disparities, was entitled to wide participation in CP. From the financial perspective 2000-2006, Poland received EUR 8.5 billion. However, in the next two planning periods of CP Poland became the main recipient of structural funds. In the years 2007-2013 and 2014-2020 the EU allocated EUR 67.2 billion and EUR 77.6 billion to Poland, respectively. Figure 2 presents the allocation of structural funds across EU countries in 2007-2020. Countries are ordered according to the highest per capita structural funds value. The support for Poland exceeded EUR 140 billion in absolute terms, which was the highest value of financial support. Spain (EUR 63 billion), Italy (EUR 61 billion), and Czechia (EUR 47 billion) were also among the most subsided countries. The left axis of Figure 2 depicts the value of structural funds per capita. In terms of per capita value, Poland (EUR 272) occupied the eighth position in the ranking. Several countries that joined the EU in 2004 received more structural funds such as Estonia (EUR 376), Slovakia (EUR 338), and Hungary (EUR 335). In the ranking, Portugal is also ahead of Poland (EUR 292), the country which has participated in the CP from the first financial perspective 1989-1993.

Place FIGURE 2

The same analysis was prepared for CAP subsidies. Figure 3 depicts both the absolute and per capita value of subsidies in the EU in 2007-2019. Again, countries are ranked from highest to lowest per capita support. The most subsided countries in absolute terms were France (EUR 113.8 billion), Germany (EUR 79.9 billion), and Spain (EUR 67.0 billion). Poland (EUR 50.5 billion) came fourth in the ranking. Considering the per capita value, Poland (EUR 102) was in the group of less supported countries. Ireland (EUR 409), Finland (EUR 352), and Greece (EUR 206) were the main beneficiary countries. However, no far-reaching conclusions should be drawn from such an analysis of the data. Other values, such as the share of the agricultural sector in the national economy or the number of farms, can serve as a reference point.

Place FIGURE 3

Figure 4 contains three maps that illustrate, respectively, the allocation of CAP subsidies, structural funds, and their coupled amount (per capita value). In the case of CAP subsidies (*agri*), the most beneficiary NUTS 3 subregions were situated in north-eastern Poland. However, there was no visible pattern of Poland's division into the western and eastern parts. Indeed, the five regions of Eastern Poland received the highest financial support i.e. Bialski (EUR 407), Łomżyński (EUR 289), Suwalski (EUR 280), Ciechanowski (EUR 240), and Ostrołęcki (EUR 233), but the southern part of Eastern Poland belonged to the areas with lower funding. As to the distribution of structural funds (*fund*) the Rzeszowskie region (EUR 371) was the most subsided area. The group of regions with the highest support covers also more developed Polish cities such as Wrocław (EUR 297), Warszawa (EUR 284) or Łódź (EUR 262) which may confirm the inequality in the funds' distribution. Finally, the third map (*agri_fund*) depicts the distribution of coupled financial resources of EU policies. In this case, it can be observed that the largest beneficiaries of CP and the CAP are located in poorer Eastern Poland.

Place FIGURE 4

4 EMPIRICAL ANALYSIS

4.1 Empirical strategy

Modeling spatial models is much more complicated than OLX models. Apart from regressors, it is necessary to control for spatial elements, i.e. the type of weight matrix or spatial lags of the dependent variable and regressors. There are still no tests to verify which specification should be more appropriate. Moreover, it is also unclear which estimation rule is better, from general to specific or from specific to general (LeSage and Pace, 2008; Florax et al., 2003). All these drawbacks make econometric strategy more of an art that requires experience in econometric modeling (Kopczewska et al., 2017).

The adopted strategy of the study consists of several steps. I begin with panel data specification using the ordinary least square (OLS) estimator. The panel data analysis is more efficient than cross-section specification because it increases the degrees of freedom and limits the collinearity among regressors (Hsiao, 2003). Then, after preparing panel OLS models for all samples of data, the specification tests are used, namely the Breusch-Pagan's (1980) test and the Hausman's (1978) test. Breusch-Pagan's test verifies whether the OLS specification should be replaced by the fixed effects estimator (FEs), while Hausman's test checks whether the random effects estimator (REs) constitutes an alternative for the FEs. On the one hand, the advantage of the FEs estimator consists in considering specific effects to each region not covered by the regressors, which may eliminate biased results (Baltagi, 2005). However, on the other hand, the higher cross-sectional variation of data reduces the efficiency of the FEs estimator (Partridge, 2005). In turn, the OLS estimator yields consistent and efficient results, if the individual heterogeneity between regions does not exist, otherwise the correctness of the estimates is lower. Since the FEs specification considers time-series variation within each region its outcomes are interpreted as short-run effects, while the OLS specification provides long-run effects (Partrige, 2005). The Bruesh-Pagan's test does not reject the OLS estimator for all samples of data which means that the regional specific effects are uncorrelated with regressors. As the econometric results confirm that all fixed effects assigned to 73 subregions are statistically insignificant, they are omitted in the further analysis.

I also try to introduce time-fixed effects, but most of them are statistically insignificant. Moreover, their inclusion removes a significant part of data variation, most of the regressors lose their statistical significance. Besides, time-fixed effects wipe out the statistical significance of spatial coefficients which constitute crucial elements of the study. Again, I decided to not consider time-fixed effects in the econometric specification. In addition, Hausman's test does not confirm that the REs estimator is more appropriate than the FEs specification. In all cases, the test's results allow rejecting this specification (q<0.05). Taking into account preliminary specifications I opt for the pooled OLS estimator for all samples of data.

The next step of the econometric approach consists of checking whether it is possible to introduce spatial components. For this, the classic LM test and the robust LM test are used (see Aselin, 1988; Elhorst, 2003). Then, I also apply the LR test to verify whether the estimated model could be nested in the simplest spatial models.

The last step of the econometric analysis is checking the robustness of the results. I repeat the econometric approach presented above, relying on cross-sectional data. As there are only 16 subregions in the EP sample, considerations are limited to the two samples of all subregions (ALL) and Western Poland subregions (WP).

In spatial models, we can control the spatial correlation for three elements i.e. spatial lag of dependent variable (ρ), spatial lags of independent variables (θ), and spatial correlation of the residuals (λ). Since the main focus of the study is the existence of spillover effects, I apply models that on the one hand contain the abovementioned spatial elements, but on the other hand, they allow tracking the spatial effects. The study assesses spillover effects taking into account their global and local character. As stressed by Aselin (2003) the difference between the two kinds of spillover effects is determined by their scope of influence. The former, due to the feedback loop, is transmitted to all regions covered by the data sample, even though regions do not have a common border. While the latter only operates in connected regions.

Equations (1) and (2) present two specifications to track global spillover effects, i.e. *Spatial Lag Model* (SAR) the *Spatial Durbin Model* (SDM), respectively

$$growth_{i,t} = \rho W growth_{i,t} + \beta X_{i,t} + e_{i,t} \tag{1}$$

$$growth_{i,t} = \rho W growth_{i,t} + \beta X_{i,t} + \theta W X_{i,t} + e_{i,t} \tag{2}$$

where ρ denotes the autoregressive parameter of the dependent variable, X is the set of regressors, W is the spatial weight matrix and e is an error term. A positive and statistically significant value of ρ indicates the existence of clusters of similar regions. The negative value of the coefficient reflects dissimilarity which could be reflected in the regional competition or the backwash effect (Kao and Bera, 2013). The spatial weight matrix describes the neighborhood between units. In the study, I used the contiguity matrix based on the common boundary criterion, where $w_{ij}$is the element of the spatial contiguity matrix, W, such that $w_{ij} = 1$ if regions i and j are neighbors and $w_{ij} = 0$ otherwise, regardless of the border length. Following the general convention, the matrix is row-standardized to 1.

The difference between the two models is that the Durbin component (θWX) is omitted in the SAR model. In addition, the SAR model has several limitations. As emphasized by Elhorst (2010) the ratio between the direct effect and the indirect effect is the same for all regressors what is not born out in many empirical studies. In turn, Pinkse and Slade (2010) point out that the entire spatial dependence structure in the SAR model comes down to one unknown parameter. Following LeSage (2014), to assess global spillover effects, the econometric analysis is restricted to the SDM model represented by Equation 2.

The dependent variable (*growth*) appears on both sides of Equation 2, after rewriting we receive

$$growth_{i,t} = (I - \rho W)^{-1}\beta X_{i,t} + (I - \rho W)^{-1}\theta W X_{i,t} + (I - \rho W)^{-1} e_{i,t} \quad (3)$$

The parameter $(I - \rho W)^{-1}$ is a feedback loop and means that the changes in the regressor of one region impact not only border areas but all regions in the sample. When comparing the models of local spillover effects (Equations 4 and 5) and global spillover effects (Equation 2), the main difference lies in the structure of the matrix *W*. In the case of the SLX and the SEDM specifications, the matrix *W* contains elements equal to zero, except when regions have a common border. In the case of the SDM model the matrix $(I - \rho W)^{-1}$ does not contain elements equal to zero, and changes in explanatory variables bring effects in all regions. Moreover, in the case of the SDM model, coefficients do not directly reflect the marginal effects of regressors. As stressed by Le Sage and Pace (2008) the total effect is the sum of effects over the row of matrix $(I - \rho W)^{-1}$. The direct effect sums the diagonal elements of the matrix $(I - \rho W)^{-1}$, while the indirect effect (spillover effect) is given by the difference between total effect and direct effect. Since the inclusion of the spatially lagged dependent variable in the SDM model creates an endogeneity problem, the estimates are based on the maximum likelihood estimator (Elhorst, 2014).

Two econometric specifications are considered to assess the local spillover effects. Equations 4 and 5 present the *Spatially lagged X model* (SLX) and the *Spatial Durbin Error Model* (SDEM), respectively

$$growth_{i,t} = \beta X_{i,t} + \theta W X_{i,t} + e_{i,t} \quad (4)$$

$$growth_{i,t} = \beta X_{i,t} + \theta W X_{i,t} + u_{i,t} \quad (5)$$

$$u_{i,t} = \lambda W u_{i,t} + e_{i,t}$$

where *X* is the set of explanatory variables, *W* represents the spatial weight matrix, $u_{i,t}$ is an error term and λ is the spatial autoregressive parameter that expresses regional characteristics that are difficult to measure and not covered by regressors. A positive value of the parameter λ indicates the existence of unobserved spatial patterns, omitted by the econometric specification i.e. language, culture, or social capital.

Both models track local spillover effects controlling for the Durbin component (θWX). Regressors have two different meanings in models with the Durbin component. The variable from the set *X* expresses the impact of the variable from the *i* region on the dependent variable *y* in the *i* region (direct effect). While the variable included in the Durbin component (θWX) describes the indirect effect (spillover effect), the impact of variable *x* in the *i* region on the dependent variable in the *j* region. Concluding, in the SLX and the SDEM models the direct effect is expressed by the β coefficient, and the indirect effect is given with θ.

4.2 Data

Data used in the study were retrieved from several sources. Annual data on Polish NUTS 3 subregions was taken from the database of Statistics Poland (Główny Urząd Statystyczny-GUS). The amount of structural funds allocated to Polish subregions was extracted from the database of the Ministry of Development Funds and Regional Policy. The value of CAP subsidies was shared by the Agency for Restructuring and Modernisation of Agriculture (ARMA) upon prior request[ii]. The graphic file of the NUTS 3 subregions in the EU was downloaded from the Eurostat website. Then the map was used to create a map of Polish NUTS 3 subregions. I also used software programs to prepare graphic and econometric parts of the study. The econometric analysis was elaborated by applying the R software. Geoda and QGIS software programs were used to create maps and figures.

All regressors were transformed into logarithmic values. The dependent variable is the annual GDP per capita growth rate ($growth_{i,t}$) of subregion *i* at time *t*. The variable *gdppc* is the initial value of GDP per capita in NUTS 3 subregions. Its negative value confirms the convergence process, poorer areas develop faster than rich ones. The key variables cover the financial resources of the EU policies. The structural funds variable (*fund*) expresses the annual average value of CP per capita. To explore the role of CAP subsidies in subregions' growth I introduce the variable (*agri_fund*) which covers CP and CAP subsidies jointly. Positive and negative signs of these variables are possible. The literature review highlights the lack of consensus in this field of research. Another relevant variable is the population density (*dens*). It relates to the agglomeration concept. The growth of both average city size and population increase productivity and thereby economic growth (Frick & Rodríguez-Pose, 2016; Fujita & Thisse, 2002; OECD, 2016; Castells-Quintana & Royuela, 2014). Moreover, Sala-i-Martin et al. (2004) enumerate population density as a positively related regressor with growth. Then, a positive value of the variable is expected. The value of investment (gross fixed capital formation) is not reported in national statistics at the subregions level. I proxy investment (*invest*) as the share of investment outlays in enterprises in GDP. A positive correlation between investment and growth is expected. According to empirical studies investment have a positive impact on regional economic growth (Mas et al. 1996; Pereira and Roca Sagalés, 2003; Rodríguez-Pose et al., 2012). I also introduce the variable of unemployment (*unemploy*). Unemployed people cannot participate in the production process. The negative sign of unemployment is expected. Besides, I tried to consider the sectoral composition of subregions' economies. However, variables expressing the share of employment in each sector turned out to be statistically significant or the collinearity problem occurred. Table 1 presents variables entered in the models along with a description of marking and the source of extraction. While tables 2-4 depict the descriptive statistic for the three samples of data.

Place TABLE 1

Place TABLES 2-4

4.3 Spatial correlation of regressors

Spatial correlation implies that the value of a variable is conditioned by the values of this variable in the neighboring location. The study uses global and local Moran's spatial statistics (Anselin, 1998). The global Moran's I statistic estimates the linear dependence between the variable in a specific location and the mean of the same variable in the neighborhood (Moran, 1950). In other words, the statistic measures the tendency to group similar values in space. The global Moran's I statistic value is contained in the bounded interval [-1,1], where 0 denotes that there is no spatial autocorrelation and -1 and 1 mean negative and positive spatial autocorrelation, respectively. The formula used to calculate the global Moran's I statistic is

$$\mathrm{I} = \frac{1}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \times \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i-\bar{x})(x_j-\bar{x})}{\frac{1}{n}\sum_{i=1}^{n}(x_i-\bar{x})^2} \tag{6}$$

where w_{ij} is the element of the spatial contiguity matrix, W, such that $w_{ij} = 1$ if regions *i* and *j* are neighbors and $w_{ij} = 0$ otherwise, x_i is the value of the variable under consideration in region *i* at time *t* and *n* is number of regions under investigation.

Table 5 provides information on global Moran's I statistic for average values of independent variables for all samples of data. In the case of ALL subregions, all statistics are positive and statistically significant confirming the spatial correlation of regressors. Besides, almost all variables in the sample of WP subregions show spatial autocorrelation, only the value of Moran I statistic of the investment variable is statistically insignificant. In turn, data concerning EP subregions, apart from the variable *agri_fund*, do not indicate positive spatial autocorrelation.

Place TABLE 5

The Moran scatterplot is used to graphically present the global Moran's I statistic. On Moran's scatterplot, the value of the x variable is presented on the horizontal axis, while the value of the weighted average of the x variable in the neighbor's regions is placed on the vertical axis. The Moran scatterplot consists of four quadrants. The first quadrant (top-right) presents the regions with a high level of the variable of interest associated with neighboring regions with a high l of the same variable (high-high). The third quadrant (bottom-left) shows the regions with a low level of the variable of interest associated with neighboring regions with low levels of the same variable (low-low). The first and third quadrants reveal the positive spatial autocorrelation. The second quadrant (top-left) presents the regions with a low level of the variable of interest associated with neighboring regions with a high level of the same variable (low-high). While the fourth quadrant (bottom-right) shows the regions with a high level of the variable of interest associated with neighboring regions with low levels of the same variable (high-low). The quadrants second and fourth highlight the negative spatial autocorrelation.

Figure 5 depicts the Moran scatterplots for the average value of regressors for ALL subregions. Most regions are placed in quadrant high-high or low-low indicating a positive spatial correlation. In other words, regions with higher values of variables tended to be located near regions with similar values, while lower values of regressors tended to be located near other low values.

Place FIGURE 5

The main disadvantage of the global Moran's I statistic is its general character. Its value shows the overall tendency towards concentration or clustering. However, the statistic is not able to indicate the geographic location of clusters. The local Moran's I_i solves this problem by identifying both clusters, in which regions with a high or low level of a variable are concentrated and outliers regions. Besides, the local Moran's I_i statistic is not calculated in global form for all observations, but groups considering the level of concentration. The local Moran's I_i statistic is represented by an expression

$$\mathrm{I}_i = \frac{(x_i - \bar{x}) \sum_{j=1}^{n} w_{ij}^{*} (x_j - \bar{x})}{\sum_{i=1}^{n} (x_i - \bar{x})^2} \quad (7)$$

where w_{ij}^{*} denotes the elements of the weight matrix calculated from the formula $w_{ij}^{*} = \frac{w_{ij}}{\sum_{j=1}^{n} w_{ij}}$, other symbols as in the formula (6). The local Moran's I_i statistic allows obtaining a LISA (Local Indicator of Spatial Association) cluster map which indicates both clusters and outliers regions (Aselin, 1995).

Figure 6 depicts the quantile and LISA maps of the average value of GDP per capita (*gdppc*) in Polish NUTS 3 subregions in 2004–2018. The quantile map shows existing regional disparities between more developed Western and less developed Eastern Poland. The concentration of rich subregions occurs in the NUTS 2 region Śląskie. Also, the high level of GDP per capita is recorded in large Polish cities such as Warszawa, Poznań, Wrocław or Łódz. On the other hand, the LISA map presents the existence of a cluster of less developed subregions in Eastern Poland.

Place FIGURE 6

4.4 Results

The starting point of empirical analysis is the estimation of panel data models without introducing spatial elements. Table 6 depicts the relevant parameter estimates using the OLS estimator for three samples of data: all subregions (ALL), Western (WP), and Eastern Poland (EP). In all cases, regressors have expected values. The *gdppc* variable is negative and statistically significant at the 1% significance level confirming convergence across subregions. The regressors *invest* and *dens* conform with expectations and have positive signs. The variable *invest* is statistically insignificant only in ES subregions. The negative value of the unemployment variable is consistent with expectations. Two regressors describe the impact of EU policies on growth. The variable *fund* covers the structural funds per capita while the variable *agri_fund* expresses the impact of the coupled value of structural funds and CAP subsidies on growth. In the case of ALL subregions, models 1 and 2, the impact of structural funds is positive but statistically insignificant while the variable *agri_fund* is positive and statistically significant confirming a positive impact on growth. In WP and EP subregions both variables are positive and statistically significant, which confirms that the EU policies boost regional growth in Polish NUTS3 subregions.

Table 6 also presents the results of the LM test and the robust LM test that verify the possibility of introducing spatial components to the econometric analysis. In the sample of ALL subregions, both tests reject the null hypothesis of no spatially lagged dependent variable ($q<0.05$). Mixed results are provided by tests for a spatially autocorrelated error term. The LM spatial error test does not reject the null hypothesis of the absence of a spatially correlated error term ($q=0.085$), while the robust spatial error test shows that the null hypothesis should be rejected (0.040). Summing up, the outcomes of the tests indicate the spatial lag specification for the sample of ALL subregions. In the case of WP subregions, all tests do not reject the null hypothesis of no spatially lagged dependent variable and no spatially correlated error term ($q>0.05$). The tests for EP subregions present mixed results. The LM spatial lag and the LM error tests allow introducing the spatial components to the econometric models while the robust versions of both tests suggest otherwise. Since the benchmark specification is based on the ALL subregions sample, both LM tests for ALL subregions permit to cover the spatially lagged dependent variable, the Spatial Durbin Model (SDM) is applied to track the global spillover effects. Although listed results do not favor the spatially autocorrelated dependent variable in WP and EP subregions and therefore the SDM specification, tables of results also present the econometric outcomes for these data samples. However, in the case of WP and EP subregions, econometric results should be interpreted cautiously. In addition, the diagnostics allow a selection of the appropriate specification to explore the local spillover effects. As the LM spatial error test does not reject the null hypothesis of on spatially lagged error term in all samples of subregions, the Spatial Durbin Error Model (SDEM) is rejected as an optimal specification and I opt for the *Spatially Lagged X* model (SLX).

Place TABLE 6

Table 7 depicts estimates of the SDM model. The specification allows tracking the global spillover effects. In all models, the coefficient of lagged dependent variable (ρ) is positive and statistically insignificant. This means that the pattern of growth in the neighbor subregions has a positive impact on local economic growth. The *gdppc* variable is positive and statistically significant proving convergence. In addition, estimates show a positive and statistically significant relationship between investment and growth and an adverse effect of unemployment on growth. The *fund* and *agri_fund* variables have positive signs but they are statistically insignificant. Only in the case of EP subregions, the *fund* variable is positive and statistically significant. Table 7 presents also the values of Loglik for the SAR and the SEM specifications. Their values are close to these of the SDM model. This means that the SDM model could be simplified to the simplest version such as the SAR or the SEM.

Place TABLE 7

The coefficients of the SDM model do not express the direct impact of regressors on the dependent variable. For the correct interpretation of the results, Tables 8 and 9 with marginal effects are presented. Tables 8 and 9 refer to the specifications with variables *fund* and *agri_fund*, respectively. Results are divided into three groups: direct, indirect, and total effect. In all samples of subregions, the indirect effect of variables *fund* and *agri_fund* is statistically insignificant. It corroborates the absence of the global spillover effects of the EU policies. The phenomenon of global spillover effects exists in the case of unemployment. For example, in ALL subregions (with *agri_fund* variable) the direct effect (0.090) is stronger than the indirect effect (spillover effect) (0.0075). The negative and statistically significant indirect effect confirms that unemployment in one subregion negatively affects growth in all subregions of the sample.

Place TABLES 8-9

The next point of the empirical analysis verifies the existence of local spillover effects of EU policies. Table 10 presents the results of estimations of Equation (4). The local spillover effects are modeled with the lags of regressors (θWX) of the SLX model. Estimates show again convergence, the variable *gdppc* is negative and statistically significant in all samples. Results confirm a positive impact of investment and adverse influence of unemployment on growth. The variables *fund* and *agri_fund* are positive and statistically significant only in EP subregions. The Durbin component (θWX) of the variables *fund* and *agri_fund* is positive and statistically significant in the samples of WP and EP, which confirms the existence of local spillover effects of structural funds and CAP subsidies. In the case of ALL subregions lagged variables of EU policies (θWX) are positive but statistically insignificant, which proves the lack of spatial effects.

Place TABLE 10

Table 11 depicts the results of the SDER model that also tracks the local spillover effects, although the LM spatial error tests (see Table 6) have shown that it is not an optimal specification. Again, the spatially lagged variables of *funds* and *agri_fund* are positive and statistically significant in WP subregions, confirming local spillover effects of the EU policies. However, comparing the results obtained using the SLX model, the lagged variables of *fund* and *agri_fund* lose their statistical significance in EP subregions. Both specifications, the SLX and the SDEM, do not bear out the hypothesis of local spillover effects in ALL subregions.

Place TABLE 11

4.5 Robustness of results

The sensitivity of the results is tested relying on cross-sectional data. The econometric approach is the same as with the panel data analysis. Since the EP sample includes only 16 observations, the econometric analysis is narrowed down to the ALL and WP samples. Table 12 depicts results applying the OLX estimator. The negative value of the regressor *gdppc* confirms convergence in both groups of subregions. Besides, the estimates show a positive impact of investment and a negative impact of unemployment on growth. The population density variable (*dens*) in all models is statistically insignificant. The variable of structural funds (*fund*) is positive in both samples but only statistically significant in WP subregions. In turn, the variable *agri_fund* is positive and statistically significant both in ALL and WP subregions, which shows the positive impact of the coupled value of structural funds and CAP subsidies on growth. Table 12 also contains the value of the LM tests. Both the LM spatial lag test and the robust LM spatial lag test reject the null hypothesis of no spatially lagged dependent variable in two samples. In contrast, the results of the LM spatial error test and the robust LM spatial error test are inconclusive. Then, to verify the global spillover effects I apply the SDM model and the SLX model is used to track the local spillover effects.

Place TABLE 12

Table 13 presents the relevant parameter estimates of the SDM model based on cross-sectional data. The variable of structural funds (*fund*) is positive but statistically insignificant in all models. In turn, a positive and statistically significant value of the variable *agri_fund* is obtained in WP subregions. As explained earlier, the coefficients of the SDM model do not directly reflect the marginal effects. Tables 14 and 15 depict the marginal effects of the SDM model. In the case of models with the variable *fund*, a positive and statistically significant indirect effect of structural funds (global spillover effect) occurs in WP subregions. The total effect of structural funds is also positive and statistically significant. In the case of ALL subregions, all effects of the variable *fund* are positive but statistically insignificant. Table 15 presents the effects of the *agri_fund* regressor. In the sample of ALL subregions, positive and statistically significant signs have the direct and total effect, but the indirect effect (global spillover effect) is statistically insignificant. In turn, in WP subregions all effects of the variable *agri_fund* are positive and statistically significant, which suggests the occurrence of the local spillover effect (indirect effect). Table 13 present also the post estimation LR test for Spatial Lagged Model (SAR) and Spatial Error Model (SEM). Both tests indicate that the SDM model is nested in the SAR model and the SEM model and these specifications would be more appropriate for data.

Place TABLES 13-15

To verify the existence of local spillover effects the SLX specification is applied (see Table 16). In the ALL subregions, the regressors *fund* and *agri_fund* and their spatial components (θWX) are positive but statistically insignificant. In turn, in the WP subregions, the regressor agri*_fund* is positive and statistically significant highlighting a positive relationship between coupled values of the EU policies and growth. Besides, in WP subregions the spatial component of the variable *fund* is positive and statistically significant, which means that the local spillover effects of structural funds occur.

Place TABLE 16

5 DISCUSION AND CONCLUSIONS

Poland successfully transitioned from a centrally planned to a free-market economy. This process has been strengthened by participation in the EU. The impact of CP and CAP subsidies is visible in the developed transport and environmental infrastructure or transformation of rural areas. Besides, from 2004 Poland has experienced strong convergence towards EU economies. According to the recent data, in 2019 a GDP per capita in Poland (purchasing power standard) reached the level of 73% of the EU average and three NUTS 2 regions i.e. Dolnośląskie (80%), Warszawski Stołeczny (160%), Wielkopolskie (79%), exceeded the level of 75% of the UE average (Eurostat). However, the economic literature may underestimate the role of the EU policies in improving the overall well-being of citizens. Data for many regressors are not provided at the regional level which hampers the econometric analysis. Moreover, the main objective of CP is not to boost regional economic growth but to achieve economic and social cohesion by promoting social inclusion or urban development. These actions not always can be reflected in the econometric analysis.

The study using spatial panel data models investigates the spatial effects of CP and CAP subsidies on the economic growth of Polish NUTS 3 subregions. Since the two policies overlap in geographic space the econometric specification covers the regressor that includes their coupled value. Results vary and depend on the data sample. In general, the econometric analysis confirms that the EU support in form of CP and CAP subsidies has a positive impact on regional growth. Besides, the existence of local spillover effects is found. Funds and subsidies operating in a given region enhance economic growth in surrounding areas. However, the results do not bear out the existence of global spillover effects of the EU policies.

Results of the econometric analysis corroborate the correctness of the approach covering the financial resources of the two policies jointly. For example, in the case of ALL subregions (see Tables 6 and 12), the regressor of structural funds is statistically insignificant, but the coupled value of CP and CAP subsidies became statistically significant highlighting a positive relationship between the EU policies and regional growth. Therefore, in line with these results covering funds of two policies separately can minimize the overall positive impact of the UE on regional growth.

The lack of effectiveness of CP in convergence is also explained by the models of the new economic geography (NEG) (Krugman, 1991; Venables 1996). Structural funds mainly co-finance the infrastructure investment i.e. the construction of new roads and motorways. Declining transport costs can lead to the concentration of economic activity in poorer, periphery areas enhancing the convergence process. However, the highest demand and the existence of economies of scale with a simultaneous reduction in transport costs can promote the concentration in the most developed areas boosting divergence.

Results also show the existence of the local spillover effects of CP and CAP subsidies. This finding is not confirmed in the recent study on spatial effects of CP in Western Union countries. Antunes et al. (2020)

using the SDM model do not detect the existence of positive spatial effects on regional growth. However, the specification without spatial effects, prepared as the preliminary strategy of the econometric approach, highlights a positive relationship between structural funds and growth. Therefore also, in this case, the results are determined by the econometric approach.

The econometric specification proposed in this study enables the tracking of the spatial impacts of other regressors. The results highlight a strong negative impact of unemployment on growth. Moreover, unemployment confirms both the local and global spillover effects. People without work in one region impact negatively on growth not only in borders regions but also throughout the country. These results can be a recommendation for policymakers to keep up developing programs and incentives to facilitate entry into the labor market.

As for further research, it would be interesting to assess the transmission channels through which spatial effects impacts regional growth in surrounding areas. The sample of data could be extended to include border countries with which Poland has stronger economic relations. In addition, the structural support of CP covers only part of the investment cost, the rest of the expenditure has to be financed by regional or local governments. It would be interesting to evaluate whether the CP funds crowd in or crowd out the regional financing of public investment. The recent econometric studies either do not give clear evidence or stress that structural funds reduce domestic public investment (García Nicolás and Cantos, 2018; González Alegre, 2010).

Appendix

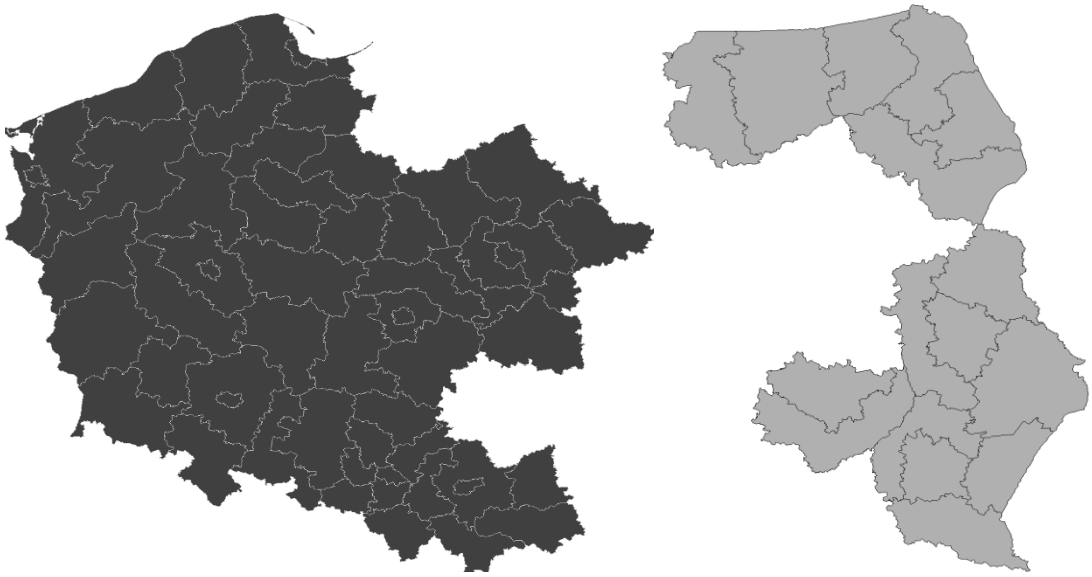


FIGURE 1 Polish NUTS 3 subregions, Western and Eastern Poland division

Note: own elaboration.

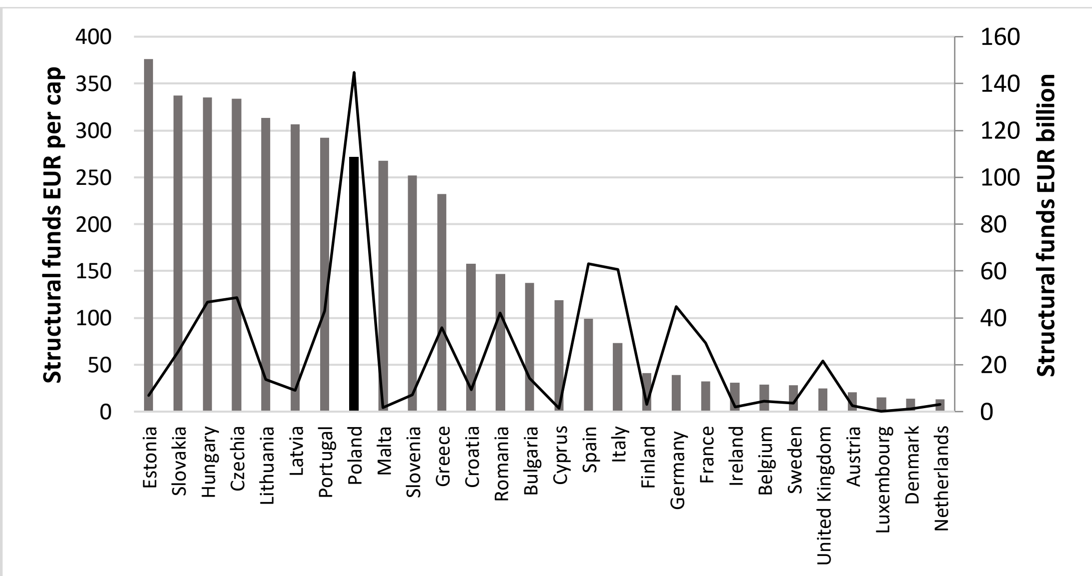


FIGURE 2 Structural funds in the EU countries in 2007-2020, annual average (euro per capita)

Note: The author's calculations are based on data from the European Commission. The amount of structural funds covers the financial resources of the European Regional Development Fund (ERDF), European Social Fund (EFS), and Cohesion Fund (CF). The solid line is the value of structural funds in absolute value (right axis). Bars show the value of structural funds per capita (left axis).

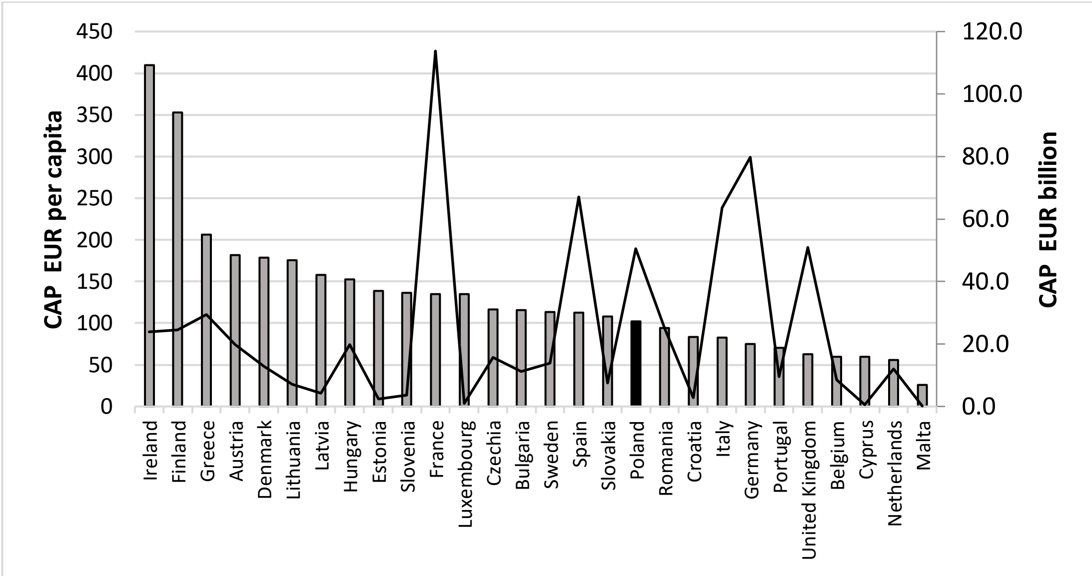
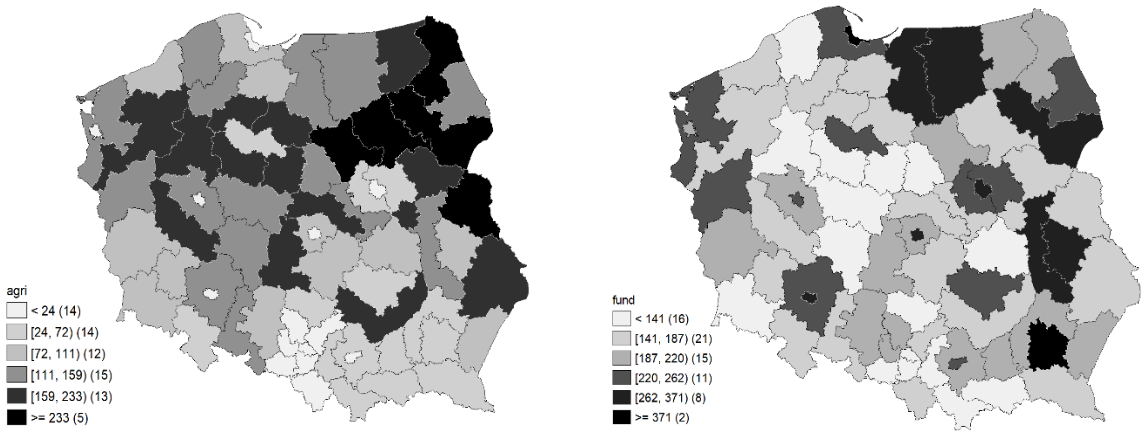


FIGURE 3 Common Agricultural Policy subsidies in 2007-2019, annual average (euro per capita)

Note: Author's calculation based on data from European FADN. The amount of Common Agricultural Policy funding covers the subsidies of I and II pilar. The solid line is the value of CAP subsidies in absolute value (right axis). Bars show the value of CAP subsidies per capita (left axis).



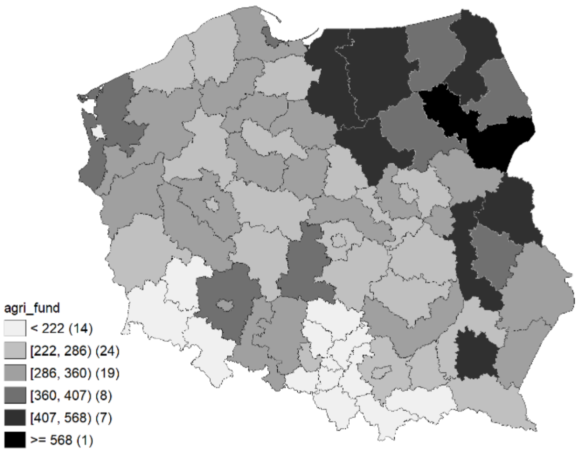


FIGURE 4 Distribution of structural funds and CAP subsidies in NUTS 3 subregions, the annual average value (euro per capita)

Note: own elaboration.

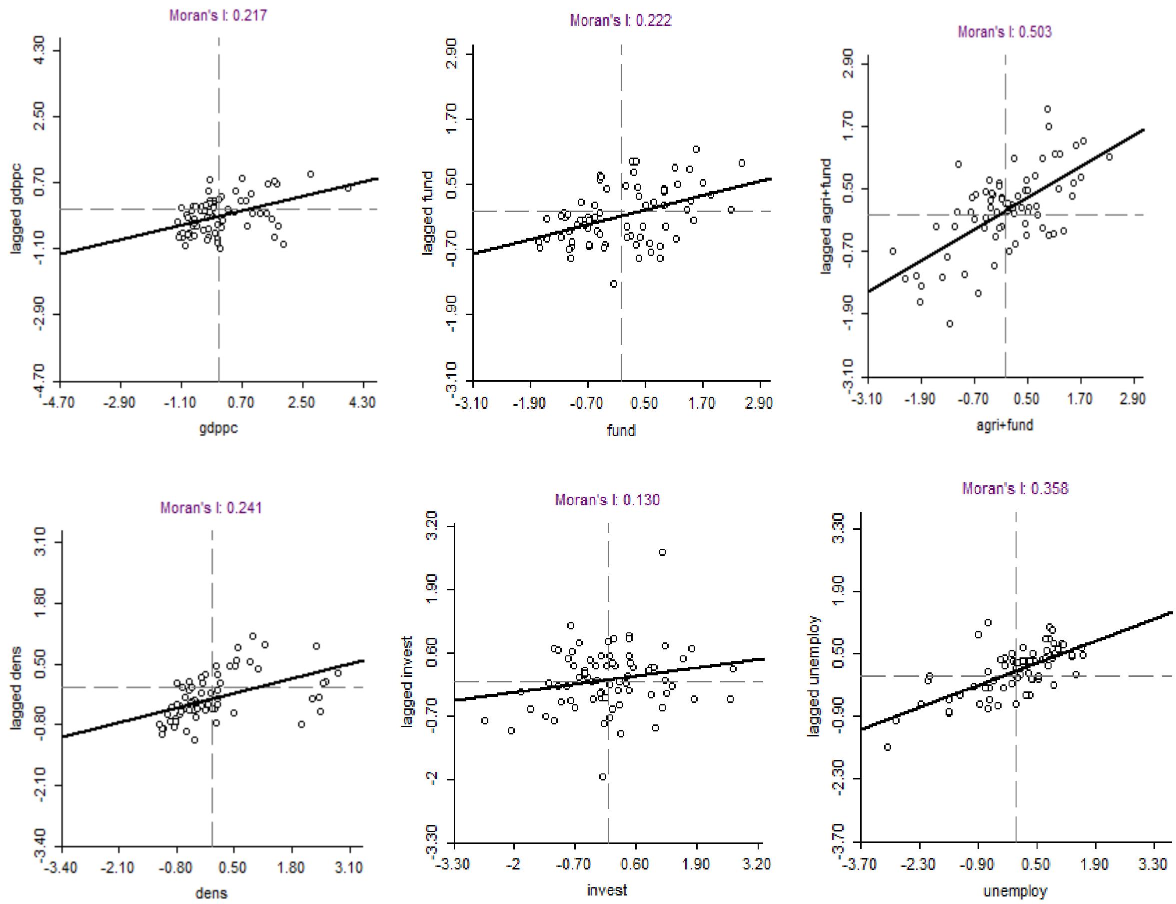


Figure 5. Moran's I scatterplots of regressors (ALL subregions)

Note: own elaboration.

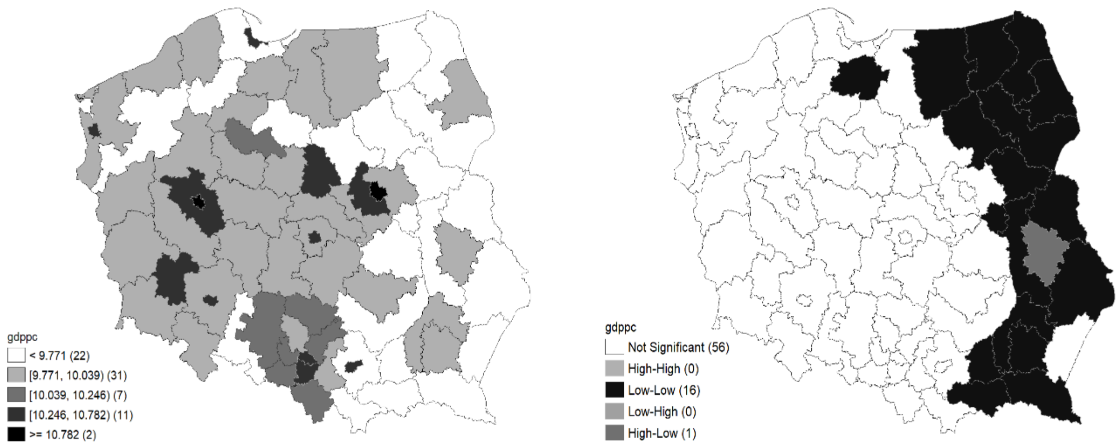


Figure 6. Average of GDP per capita (left) and LISA cluster map (right)

Note: own elaboration.

TABLE 1 The set of regressors entered in the econometric models

Variable	Marking	Description	Source of data
Economic growth	*growth*	The logarithm of the annual growth rate of GDP per capita	Statistics Poland (GUS)
Gross domestic product per capita	*gdppc*	The logarithm of the initial value of GDP per capita	Statistics Poland (GUS)
Structural funds	*fund*	The logarithm of the annual average value of structural funds per capita	Ministry of Development Funds and Regional Policy
Structural funds and CAP subsidies	*agri_fund*	The logarithm of the coupled value of structural funds and CAP subsidies per capita	Ministry of Development Funds and Regional Policy; Agency for Restructuring and Modernisation of Agriculture (ARMA)
Population density	*dens*	The logarithm of the number of people per square kilometer	Statistics Poland (GUS)
Investment	*invest*	The logarithm of the investment outlays in enterprises calculated as a percentage of GDP	Statistics Poland (GUS)
Unemployment	*unemploy*	The logarithm of the share of the labor force without work	Statistics Poland (GUS)

Note: own elaboration.

TABLE 2 Descriptive statistics. All subregions (ALL)

Variable	Mean	Median	S.D.	Min.	Max.
gdppc	34622.3	301517.1	16522.6	14589.0	152833.0
fund	191.6	171.9	63.63	104.3	403.0
agri_fund	291.8	281.7	86.9	127.7	583.6

dens	361.4	103	675.3	42	3412
invest	8.066	7.4	2.68	2.9	22.9
unemploy	13.65	13.2	5.95	1.4	34.9

Note: own elaboration.

TABLE 3 Descriptive statistics. Western Poland (WP)

Variable	Mean	Median	S.D.	Min.	Max.
gdppc	36935.0	32776.0	17674.9	14589.0	152833.0
fund	179.3	158.4	57.1	104.3	403.0
agri_fund	268.1	269.7	69.4	127.7	447.8
dens	436.6	116.0	746.7	42	3412
invest	8.38	7.7	2.77	4.0	22.9
unemploy	13.03	12.35	6.18	1.4	34.6

Note: own elaboration.

TABLE 4 Descriptive statistics. Eastern Poland (EP)

Variable	Mean	Median	S.D.	Min.	Max.
gdppc	26565.8	25965.0	70003.5	14897	47642
fund	235.4	210.6	66.2	155.1	380.5
agri_fund	376.1	372.3	90.9	224.1	583.6
dens	91.5	81.0	42.9	44	180
invest	6.92	6.5	1.96	2.9	13.3
unemploy	15.4	14.85	4.57	7.3	34.9

Note: own elaboration.

TABLE 5 Moran's I statistic of regressors

Variable	Moran's I statistic		
	ALL	WP	EP
gdppc	0.217	0.142	-0.201
	(0.0014)	(0.0393)	(0.7478)
fund	0.222	0.246	-0.082
	(0.0014)	(0.0021)	(0.5316)
agri_fund	0.503	0.411	0.365
	(0.0000)	(0.0000)	(0.0135)
dens	0.241	0.193	0.2432
	(0.0005)	(0.0108)	(0.0558)
invest	0.130	0.017	-0.0871
	(0.0338)	(0.3534)	(0.5429)
unemploy	0.358	0.324	0.1221
	(0.0000)	(0.0001)	(0.1244)

Note: ALL, full sample of NUTS 3 subregions; WP, Western Poland subregions; EP, Eastern Poland subregions.

TABLE 6 Panel OLX model and spatial dependence tests

Dep. variable:	ALL		WP		EP	
growth	1	2	3	4	5	6
Const	0.5436***	0.5091***	0.5274***	0.4920***	0.6348***	0.4821***
	(0.0542)	(0.0568)	(0.0622)	(0.0633)	(0.1099)	(0.1279)
gdppc_{t-1}	–0.0500***	–0.0502***	–0.0503***	–0.0514***	–0.0668***	–0.0609***
	(0.0045)	(0.0045)	(0.0051)	(0.0051)	(0.0102)	(0.0101)
fund	0.0055		0.0106*		0.0291***	
	(0.0036)		(0.0049)		(0.0083)	
agri_fund		0.0098*		0.0157**		0.0285**
		(0.0039)		(0.0049)		(0.0101)
dens	0.0058***	0.0077***	0.0043**	0.0071***	0.0088*	0.0218***
	(0.0013)	(0.0014)	(0.0015)	(0.0015)	(0.0045)	(0.0060)
invest	0.0124**	0.0123**	0.0130**	0.0125**	–0.0082	–0.0054
	(0.0038)	(0.0038)	(0.0044)	(0.0044)	(0.0077)	(0.0077)
unemploy	–0.0200***	–0.0195***	–0.0192***	–0.0193***	–0.0307***	–0.0233**
	(0.0033)	(0.0033)	(0.0037)	(0.0037)	(0.0086)	(0.0088)
Observations	1022	1022	798	798	224	224
R^2	0.11	0.12	0.12	0.13	0.18	0.17
F-statistic	25.5688	26.409	21.0658	22.3396	4.5972	8.6596
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0003)	(0.0000)
LM spatial lag	5.2917	5.1071	0.0648	0.0131	0.0266	0.0817
	(0.0214)	(0.0238)	(0.7991)	(0.9087)	(0.8702)	(0.7750)
Robust LM	6.5212	6.9427	0.3409	0.7913	6.6007	7.8461
spatial lag	(0.0106)	(0.0084)	(0.5593)	(0.3737)	(0.0101)	(0.0050)
LM spatial	2.9498	2.6997	0.0113	0.0166	0.5725	0.4350
error	(0.0858)	(0.1004)	(0.9150)	(0.8973)	(0.4493)	(0.5095)
Robust LM	4.1794	4.5355	0.2878	0.7948	7.1486	8.1974
spatial error	(0.0409)	(0.0332)	(0.5918)	(0.3726)	(0.0075)	(0.0041)
Bruesch	1.4070	0.9192	0.5237	0.1952	0.2835	0.1273
Pagan Test	(0.2364)	(0.3377)	(0.4692)	(0.6586)	(0.5934)	(0.7212)

Note: The dependent variable is GDP per capita growth (*growth*). ALL, the full sample of NUTS 3 subregions; WP, Western Poland subregions; EP, Eastern Poland subregions. Standard errors in parenthesis.
*q < 0.1 denotes significance at 10% level. **q < 0.05 denotes significance at 5% level. ***q < 0.01 denotes significance at 1% level.

TABLE 7 Results of the Spatial Durbin Model (SDM)

Dep. variable: growth	ALL		WP		EP	
	1	2	3	4	5	6
Rho (ρ)	0.4904***	0.4884***	0.4144***	0.4110***	0.5317***	0.5498***
	(0.0303)	(0.0303)	(0.0366)	(0.0367)	(0.0500)	(0.0486)
Const	0.4352***	0.3689**	0.3861***	0.3370***	0.3936	0.4903
	(0.0749)	(0.0804)	(0.0886)	(0.0925)	(0.1233)	(0.2988)
$gdppc_{t-1}$	–0.0185**	–0.0178**	–0.0191**	–0.0204**	–0.0299*	–0.0374*
	(0.0059)	(0.0058)	(0.0066)	(0.0065)	(0.0181)	(0.0187)
fund	0.0037		0.0051		0.0194*	
	(0.0035)		(0.0047)		(0.0095)	
agri_fund		0.0058		0.0052		0.0152
		(0.0046)		(0.0056)		(0.0122)
dens	0.0020	0.0024	0.0010	0.0010	0.0079	0.0155*
	(0.0017)	(0.0017)	(0.0020)	(0.0019)	(0.0084)	(0.0077)
invest	0.0089*	0.0088*	0.0095*	0.0090*	0.0005	–0.0001
	(0.0034)	(0.0034)	(0.0041)	(0.0041)	(0.0059)	(0.0060)
unemploy	–0.0093*	–0.0085*	–0.0094*	–0.0093*	–0.0152	–0.0174
	(0.0043)	(0.0042)	(0.0067)	(0.0046)	(0.0105)	(0.0115)
$W \times gdppc_{t-1}$	–0.0183*	–0.0191**	–0.0245**	–0.0248**	–0.0163	–0.0017
	(0.0072)	(0.0072)	(0.0081)	(0.0081)	(0.0201)	(0.0188)
W×fund	–0.0039		0.0209*		0.0150	
	(0.0072)		(0.0111)		(0.0138)	
W×agri_fund		0.0025		0.0236*		–0.0198
		(0.0082)		(0.0113)		(0.0244)
W×dens	–0.0004	0.0022	–0.0016	0.0080*	–0.0052	–0.0196
	(0.0028)	(0.0039)	(0.0030)	(0.0040)	(0.0102)	(0.0177)
W×invest	–0.0024	–0.0014	–0.0027	–0.0027	–0.0084	–0.0055
	(0.0054)	(0.0054)	(0.0064)	(0.0065)	(0.0086)	(0.0086)
W×unemploy	–0.0080	–0.0085	–0.0101	–0.0107*	–0.0142	–0.0019
	(0.0057)	(0.0058)	(0.0064)	(0.0063)	(0.0144)	(0.0130)
Observations	1022	1022	798	798	224	224
R^2	0.13	0.12	0.16	0.16	0.21	0.21
Log lik	2118.2	2118.0	1627.9	1627.9	515.0	513.7
AIC	–3922.7	–3921.6	–3112.8	–3050.7	–900.3	–898.6
Log lik SAR	2114.2	2116.0	1613.6	1615.7	512.3	512.2
Log lik SEM	2105.9	2106.7	1606.3	1607.2	509.4	509.3

Note: The dependent variable is GDP per capita growth (*growth*). ALL, the full sample of NUTS 3 subregions; WP, Western Poland subregions; EP, Eastern Poland subregions. Standard errors in parenthesis.
*q < 0.1 denotes significance at 10% level. **q < 0.05 denotes significance at 5% level. ***q < 0.01 denotes significance at 1% level.

TABLE 8 Marginal effects of the Spatial Durbin Model (SDM) with the regressor *fund*

	ALL			WP			EP		
	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total
lny	–0.0198***	–0.0166**	–0.0364***	–0.0200**	–0.0126**	–0.0326**	–0.0339	–0.0300	–0.0639
	(0.0058)	(0.0054)	(0.0111)	(0.0069)	(0.0050)	(0.0118)	(0.0211)	(0.0204)	(0.0410)
fund	0.0039	0.0033	0.0072	0.0054	0.00634	0.0088	0.0220*	0.0194	0.0415*
	(0.0039)	(0.0034)	(0.0073)	(0.0046)	(0.0030)	(0.0077)	(0.0109)	(0.0115)	(0.0221)
dens	0.0021	0.0018	0.0039	–0.0011	–0.0007	–0.0018	0.0090	0.0076	0.0166
	(0.0018)	(0.0015)	(0.0033)	(0.0021)	(0.0013)	(0.0035)	(0.0100)	(0.0093)	(0.0193)
invest	0.0094*	0.0079*	0.0173*	0.0100*	0.0063*	0.0163*	–0.0006	–0.0005	–0.0011
	(0.0036)	(0.0033)	(0.0068)	(0.0035)	(0.0041)	(0.0076)	(0.0064)	(0.0060)	(0.0124)
unemploy	–0.0099*	–0.0083*	–0.0183*	–0.0098*	–0.0062	–0.0161*	–0.0172	–0.0152	–0.0324
	(0.0044)	(0.0039)	(0.0083)	(0.0052)	(0.0037)	(0.0088)	(0.0130)	(0.0125)	(0.0255)

Note: ALL, the full sample of NUTS 3 subregions; WP, Western Poland subregions; EP, Eastern Poland subregions. Standard errors in parenthesis.
*q < 0.1 denotes significance at 10% level. **q < 0.05 denotes significance at 5% level. ***q < 0.01 denotes significance at 1% level.

TABLE 9 Marginal effects of the Spatial Durbin Model (SDM) with the regressor *agri_fund*

	ALL			WP			EP		
	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total
lny	–0.0189**	–0.0158**	–0.0348**	–0.0214**	–0.0133**	–0.0347**	–0.0429*	–0.0403	–0.0832*
	(0.0062)	(0.0054)	(0.0114)	(0.0063)	(0.0045)	(0.0106)	(0.0218)	(0.0233)	(0.0445)
agri_fund	0.0062	0.0051	0.0113	0.0054	0.0034	0.0088	0.0132	0.0123	0.0256
	(0.0049)	(0.0043)	(0.0092)	(0.0063)	(0.0041)	(0.0104)	(0.0136)	(0.0139)	(0.0273)
dens	0.0026	0.0021	0.0048	0.0011	0.0007	0.0018	0.0177*	0.0166	0.0344*
	(0.0019)	(0.0016)	(0.0036)	(0.0021)	(0.0013)	(0.0035)	(0.0087)	(0.0096)	(0.0180)
invest	0.0093*	0.0078*	0.0172*	0.0095*	0.0059*	0.0154*	0.0001	0.0001	0.0002
	(0.0037)	(0.0033)	(0.0071)	(0.0041)	(0.0027)	(0.0068)	(0.0069)	(0.0067)	(0.0136)
unemploy	–0.0090*	–0.0075*	–0.0166*	–0.0097*	–0.0060	–0.0158*	–0.0200	–0.0188	–0.0388
	(0.0046)	(0.0041)	(0.0087)	(0.0046)	(0.0030)	(0.0076)	(0.0131)	(0.0138)	(0.0266)

Note: see the note for Table 8.

TABLE 10 Results of the Spatially Lagged X model (SLX)

Dep. variable: growth	ALL		WP		EP	
	1	2	3	4	5	6
Constant	0.7300***	0.7249***	0.6223***	0.6213***	0.7907***	0.7867***
	(0.0921)	(0.0920)	(0.1017)	(0.0865)	(0.1592)	(0.1606)
$gdppc_{t-1}$	–0.0220***	–0.0217**	–0.0233**	–0.0232**	–0.0295	–0.0300
	(0.0067)	(0.0067)	(0.0072)	(0.0077)	(0.0234)	(0.0238)
fund	0.0005		0.0044		0.0331**	
	(0.0041)		(0.0053)		(0.0122)	
agri_fund		0.0059		0.0058		0.0355**
		(0.0052)		(0.0056)		(0.0124)
dens	0.0026	0.0032*	0.0005	0.0015	0.0019	0.0018
	(0.0019)	(0.0012)	(0.0020)	(0.0019)	(0.0109)	(0.0108)
invest	0.0104**	0.0097*	0.0094*	0.0092*	–0.0048	–0.0048
	(0.0039)	(0.0039)	(0.0045)	(0.0051)	(0.0077)	(0.0078)
unemploy	–0.0110*	–0.0097*	–0.0094*	–0.0094**	–0.0120	–0.0122
	(0.0049)	(0.0046)	(0.0043)	(0.0034)	(0.0136)	(0.0137)
$W \times gdppc_{t-1}$	–0.0497***	–0.0501***	–0.0546***	–0.0545***	–0.0638*	–0.0640*
	(0.0082)	(0.0082)	(0.0089)	(0.0098)	(0.0260)	(0.0260)
W×fund	0.0137		0.0332***		0.0407*	
	(0.0087)		(0.0075)		(0.0178)	
$W \times agri\_fund$		0.0088		0.0371***		0.0426*
		(0.0094)		(0.0088)		(0.0180)
$W \times dens$	0.0054	0.0047	0.0019	0.0161***	0.0034	0.0034
	(0.0044)	(0.0044)	(0.0034)	(0.0032)	(0.0132)	(0.0132)
$W \times invest$	0.0051	0.0064	0.0041	0.0037	–0.0248*	–0.0249*
	(0.0062)	(0.0062)	(0.0071)	(0.0084)	(0.0111)	(0.0110)
$W \times unemploy$	–0.0211**	–0.0222***	–0.0239***	–0.0245***	–0.0456*	–0.0456*
	(0.0066)	(0.0067)	(0.0070)	(0.0054)	(0.0186)	(0.0187)
Observations	1022	1022	798	798	224	224
R^2	0.15	0.15	0.17	0.17	0.25	0.25
F-statistic	17.502	17.649	15.592	16.210	7.245	7.267
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Note: The dependent variable is GDP per capita growth (*growth*). ALL, the full sample of NUTS 3 subregions; WP, Western Poland subregions; EP, Eastern Poland subregions. Standard errors in parenthesis.
*q < 0.1 denotes significance at 10% level. **q < 0.05 denotes significance at 5% level. ***q < 0.01 denotes significance at 1% level.

TABLE 11 Results of Spatial Durbin Error Model (SDER)

Dep. variable:	ALL		WP		EP	
growth	1	2	3	4	5	6
Lambda (λ)	0.4881***	0.5076***	0.4053***	0.4062***	0.5437***	0.5631***
	(0.0308)	(0.0290)	(0.0380)	(0.0378)	(0.0518)	(0.0495)
Constant	0.6510***	0.6316***	0.5663***	0.5493***	0.2837***	0.6920
	(0.1219)	(0.1231)	(0.1275)	(0.1283)	(0.0826)	(0.3316)
gdppc_{t-1}	–0.0242***	–0.0238***	–0.0259***	–0.0258***	–0.0341***	–0.0466**
	(0.0055)	(0.0054)	(0.0061)	(0.0061)	(0.0077)	(0.0158)
fund	0.0034		0.0040		0.0208***	
	(0.0035)		(0.0085)		(0.0062)	
agri_fund		0.0062		0.0074		0.0158
		(0.0043)		(0.0053)		(0.0116)
dens	0.0023	0.0032*	0.0010	0.0021	0.0061	0.0174*
	(0.0015)	(0.0012)	(0.0017)	(0.0018)	(0.0037)	(0.0072)
invest	0.0095**	0.0093*	0.0104*	0.0095*	–0.0014	0.0032
	(0.0036)	(0.0035)	(0.0042)	(0.0042)	(0.0058)	(0.0069)
unemploy	–0.0112**	–0.0105***	–0.0114***	–0.0111*	–0.0184**	–0.0224*
	(0.0041)	(0.0041)	(0.0046)	(0.0046)	(0.0065)	(0.0109)
$\mathrm{W} \times \mathrm{gdppc}_{t-1}$	–0.0381***	–0.0386***	–0.0406***	–0.0405***	–0.0298	–0.0298
	(0.0085)	(0.0085)	(0.0091)	(0.0091)	(0.0190)	(0.0190)
W×fund	0.0072		0.0281*		0.0104	
	(0.0092)		(0.0120)		(0.0230)	
W×agri_fund		0.0062		0.0257*		0.0104
		(0.0092)		(0.0122)		(0.0230)
W×dens	0.0054	0.0056	0.0101*	0.0101*	–0.0061	–0.0061
	(0.0043)	(0.0043)	(0.0049)	(0.0048)	(0.0168)	(0.0168)
W×invest	0.0026	0.0035	0.0012	0.0011	0.0064	0.0064
	(0.0066)	(0.0067)	(0.0075)	(0.0076)	(0.0110)	(0.0110)
W×unemploy	–0.0159*	–0.0161*	–0.0164*	–0.0163*	–0.0088	–0.0088
	(0.0067)	(0.0067)	(0.0071)	(0.0071)	(0.0149)	(0.0149)
Observations	1022	1022	798	798	224	224
R^2	0.14	0.15	0.16	0.17	0.14	0.19
Log lik	2115.7	2116.3	1616.8	1617.3	512.3	512.8
Log lik SEM	2105.9	2106.7	1606.3	1607.2	509.4	509.3

Note: The dependent variable is GDP per capita growth (*growth*). ALL, the full sample of NUTS 3 subregions; WP, Western Poland subregions; EP, Eastern Poland subregions. Standard errors in parenthesis.
*q < 0.1 denotes significance at 10% level. **q < 0.05 denotes significance at 5% level. ***q < 0.01 denotes significance at 1% level.

TABLE 12 Results of OLX model and spatial dependence tests (cross-sectional data)

Dep. variable: growth	ALL		WP	
	1	2	3	4
Const	0.1396**	0.1163**	0.1422**	0.1211**
	(0.0407)	(0.0404)	(0.0455)	(0.0429)
$gdppc_{t-1}$	–0.0104*	–0.0106**	–0.0109*	–0.0116**
	(0.0040)	(0.0039)	(0.0043)	(0.0040)
fund	0.0038		0.0064*	
	(0.0020)		(0.0028)	
agri_fund		0.0065**		0.0093***
		(0.0022)		(0.0026)
dens	–0.0003	0.0010	–0.0008	0.000
	(0.0010)	(0.0010)	(0.0011)	(0.0010)
invest	0.0103**	0.0103**	0.0071	0.0065
	(0.0035)	(0.0034)	(0.0043)	(0.0040)
unemploy	–0.0093***	–0.0086***	–0.0093**	–0.0091***
	(0.0024)	(0.0023)	(0.0027)	(0.0025)
Observations	73	73	57	57
R^2	0.33	0.38	0.35	0.43
LM spatial lag	10.039	7.5542	11.596	8.5562
	(0.0015)	(0.0059)	(0.0006)	(0.0034)
Robust LM	4.022	5.1774	8.9638	7.6174
spatial lag	(0.0449)	(0.0228)	(0.0027)	(0.0057)
LM spatial	6.6484	3.7868	5.5607	3.5599
error	(0.0099)	(0.0516)	(0.0184)	(0.0668)
Robust LM	0.6317	1.41	2.9283	2.4211
spatial error	(0.4269)	(0.2351)	(0.0870)	(0.1197)
F-statistic	6.721	8.264	5.588	7.671
	(0.0000)	(0.0000)	(0.0003)	(0.0000)

Note: The dependent variable is GDP per capita growth (*growth*). ALL, the full sample of NUTS 3 subregions; WP, Western Poland subregions; EP, Eastern Poland subregions. Standard errors in parenthesis.
*q < 0.1 denotes significance at 10% level. **q < 0.05 denotes significance at 5% level. ***q < 0.01 denotes significance at 1% level.

TABLE 13 Results of Spatial Durbin Model (SDM) (cross-sectional data)

Dep. variable: growth	ALL		WP	
	1	2	3	4
Rho (ρ)	0.2927	0.2250	0.2015	0.1552
	(0.1421)	(0.1521)	(0.3015)	(0.4208)
Const	0.1332	0.1222	0.1212	0.1246
	(0.0738)	(0.0701)	(0.0709)	(0.0667)
$gdppc_{t-1}$	–0.0118**	–0.0114**	–0.0100*	–0.0103*
	(0.0039)	(0.0039)	(0.0041)	(0.0040)
fund	0.0031		0.0044	
	(0.0021)		(0.0026)	
agri_fund		0.0052		0.0066*
		(0.0028)		(0.0031)
dens	0.0003	0.0011	–0.0016	0.0001
	(0.0011)	(0.0010)	(0.0012)	(0.0010)
invest	0.0121***	0.0118***	0.0091*	0.0078*
	(0.0034)	(0.0034)	(0.0038)	(0.0038)
unemploy	–0.0067*	–0.0061*	–0.0068*	–0.0065*
	(0.0026)	(0.0026)	(0.0027)	(0.0026)
W × $gdppc_{t-1}$	0.0017	–0.0013	–0.0045	–0.0083
	(0.0069)	(0.0068)	(0.0067)	(0.0066)
W×fund	0.0007		0.0119	
	(0.0032)		(0.0062)	
W×agri_fund		0.0024		0.0101
		(0.0050)		(0.0064)
W×dens	–0.0025	–0.0006	–0.0003	0.0032
	(0.0019)	(0.0026)	(0.0020)	(0.0027)
W×invest	–0.0007	0.0021	–0.0019	0.0049
	(0.0057)	(0.0057)	(0.0061)	(0.0060)
W×unemploy	–0.0048	–0.0054	–0.0052	–0.0056
	(0.0048)	(0.0047)	(0.0047)	(0.0045)
Observations	73	73	57	57
R^2	0.43	0.45	0.49	0.52
Log lik	288.63	290.13	227.97	230.13
AIC	–551.26	–554.28	–429.95	–434.28
LR Spatial lag	2.1634	1.7188	3.8537	3.4837
	(0.8261)	(0.8865)	(0.5707)	(0.6259)
LR Spatial error	3.687	3.94	6.4151	6.2253
	(0.5953)	(0.5581)	(0.2679)	(0.2849)

Note: The dependent variable is GDP per capita growth (*growth*). ALL, the full sample of NUTS 3 subregions; WP, Western Poland subregions; EP, Eastern Poland subregions. Standard errors in parenthesis.
*q < 0.1 denotes significance at 10% level. **q < 0.05 denotes significance at 5% level. ***q < 0.01 denotes significance at 1% level.

TABLE 14 Marginal effects of the Spatial Durbin Model (SDM) with the regressor *fund*

(cross-sectional data)

	ALL			WP		
	Direct	Indirect	Total	Direct	Indirect	Total
lny	–0.0119*	–0.0022	–0.0142*	–0.0103*	–0.0079	–0.0182
	(0.0048)	(0.0066)	(0.0060)	(0.0042)	(0.0081)	(0.0098)
fund	0.0032	0.0022	0.0055	0.0050	0.0154*	0.0205**
	(0.0017)	(0.0043)	(0.0043)	(0.0031)	(0.0071)	(0.0070)
dens	0.0002	–0.0033	–0.0030	–0.0016	–0.0008	–0.0025
	(0.0008)	(0.0020)	(0.0021)	(0.0012)	(0.0021)	(0.0014)
invest	0.0123***	0.0037	0.0160**	0.0093**	0.0045	0.0138
	(0.0033)	(0.0052)	(0.0066)	(0.0043)	(0.0117)	(0.0143)
unemploy	–0.0072*	–0.0091	–0.0164*	–0.0071	–0.0080*	–0.0152***
	(0.0028)	(0.0054)	(0.0052)	(0.0028)	(0.0050)	(0.0045)

Note: ALL, the full sample of NUTS 3 subregions; WP, Western Poland subregions; EP, Eastern Poland subregions. Standard errors in parenthesis.
*q < 0.1 denotes significance at 10% level. **q < 0.05 denotes significance at 5% level. ***q < 0.01 denotes significance at 1% level.

TABLE 15 Marginal effects of the Spatial Durbin Model (SDM) with the regressor *agri_fund*

(cross-sectional data)

	ALL			WP		
	Direct	Indirect	Total	Direct	Indirect	Total
lny	–0.0116***	–0.0049	–0.0165**	–0.0107**	–0.0114	–0.0221**
	(0.0025)	(0.0082)	(0.0092)	(0.0034)	(0.0082)	(0.0069)
agri_fund	0.0053*	0.0045	0.099*	0.0071*	0.0128**	0.0199***
	(0.0028)	(0.0051)	(0.0056)	(0.0029)	(0.0047)	(0.0037)
dens	0.0011*	-0.0004	0.0006	0.0002	0.0037	0.0040
	(0.0010)	(0.0033)	(0.0035)	(0.0008)	(0.0019)	(0.0019)
invest	0.0120**	0.0060	0.0181	0.0081	0.0071	0.0152
	(0.0034)	(0.0114)	(0.0135)	(0.0044)	(0.0093)	(0.0097)
unemploy	–0.0065**	–0.00	–0.0150**	–0.0068*	–0.0077*	–0.0145***
	(0.0022)	(0.0062)	(0.0064)	(0.0028)	(0.0034)	(0.0022)

Note: ALL, the full sample of NUTS 3 subregions; WP, Western Poland subregions; EP, Eastern Poland subregions. Standard errors in parenthesis.
*q < 0.1 denotes significance at 10% level. **q < 0.05 denotes significance at 5% level. ***q < 0.01 denotes significance at 1% level.

TABLE 16 Results of Spatially Lagged X model (SLX) (cross-sectional data)

Dep. variable: growth	ALL		WP	
	1	2	3	4
Const	0.1831*	0.1595*	0.1708*	0.1640*
	(0.0794)	(0.0749)	(0.0765)	(0.0720)
$\mathrm{gdppc}_{\mathbf{t-1}}$	–0.0121**	–0.0117**	–0.0104*	–0.0108*
	(0.0044)	(0.0043)	(0.0046)	(0.0045)
fund	0.0034		0.0048	
	(0.0024)		(0.0030)	
agri_fund		0.0057		0.0070*
		(0.0031)		(0.0035)
dens	0.0002	0.0012	0.0017	0.0002
	(0.0012)	(0.0011)	(0.0013)	(0.0012)
invest	0.0130**	0.0124**	0.0097*	0.0083*
	(0.0038)	(0.0037)	(0.0043)	(0.0042)
unemploy	–0.0072*	–0.0064*	–0.0068*	–0.0065*
	(0.0030)	(0.0029)	(0.0031)	(0.0029)
$\mathrm{W} \times \mathrm{gdppc}_{\mathrm{t-1}}$	–0.0024	–0.0051	–0.0093	–0.0123
	(0.0075)	(0.0073)	(0.0073)	(0.0071)
W×fund	0.0027		0.0147*	
	(0.0048)		(0.0068)	
$\mathrm{W} \times \mathrm{agri\_fund}$		0.0041		0.0121
		(0.0054)		(0.0069)
$\mathrm{W} \times \mathrm{dens}$	–0.0033	–0.0006	–0.0007	0.0034
	(0.0022)	(0.0029)	(0.0022)	(0.0030)
$\mathrm{W} \times \mathrm{invest}$	0.0045	0.0066	0.0049	0.0074
	(0.0061)	(0.0060)	(0.0068)	(0.0067)
$\mathrm{W} \times \mathrm{unemploy}$	–0.0084	–0.0083	–0.087	–0.0083*
	(0.0051)	(0.0050)	(0.0040)	(0.0047)
Observations	73	73	57	57
R^2	0.39	0.43	0.47	0.51
F-statistic	4.019	4.661	4.145	4.904
	(0.0001)	(0.0000)	(0.0004)	(0.0000)

Note: The dependent variable is GDP per capita growth (*growth*). ALL, the full sample of NUTS 3 subregions; WP, Western Poland subregions; EP, Eastern Poland subregions. Standard errors in parenthesis.
*q < 0.1 denotes significance at 10% level. **q < 0.05 denotes significance at 5% level. ***q < 0.01 denotes significance at 1% level.

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Note

[i] NUTS is a geographical nomenclature subdividing the territory of the European Union (EU) into regions at three different levels (NUTS 1, 2, and 3, respectively, moving from larger to smaller territorial units). Above NUTS 1 is the 'national' level of the Member State. NUTS areas aim to provide a single and coherent territorial breakdown for the compilation of EU regional statistics.

[ii] The author wishes to thank the ARMA authorities for sharing data on the CAP subsidies in NUTS 3 subregions in Poland.