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Heterogeneous Effects of the Cohesion Policy on Economic Growth in Poland: A Panel Data Analysis from 2007 to 2020

Zróżnicowany wpływ polityki spójności na wzrost gospodarczy w Polsce: analiza na podstawie danych panelowych w latach 2007–2020

Abstract

The aim of the study is twofold. Firstly, it examines the heterogeneous effects of Cohesion Policy on the growth of the NUTS 3 subregions of Poland. Secondly, it evaluates whether differences in Cohesion Policy outcomes are linked to the level of assistance. The econometric analysis spans the two planning periods of Cohesion Policy, covering 2007 to 2020. By using the dynamic Mean Group (DM) model, the study finds that Cohesion Policy produces a positive impact in 33 subregions (45%), an insignificant impact in 36 subregions (49%), and a negative impact in 4 subregions (5%). Furthermore, the econometric analysis finds that the effectiveness of EU policy is not determined solely by the assistance allocated to subregions. There are NUTS 3 units where a below-average influx of funds has yielded positive results, and others where a great deal of assistance has negatively affected economic performance. These results remain robust across various econometric approaches.

Keywords: Poland, Cohesion Policy, Subregional Growth, Heterogenous Results.

JEL: R11, R12, R58

Streszczenie

Opracowanie ma dwa cele. Po pierwsze, bada zróżnicowany wpływ polityki spójności UE na rozwój podregionów NUTS 3 w Polsce. Po drugie, weryfikuje, czy zróżnicowane rezultaty polityki spójności są powiązane z poziomem otrzymanej pomocy. Analiza ekonometryczna obejmuje dwa okresy planistyczne, obejmujące lata 2007–2020. Wykorzystując dynamiczne modele panelowe (Mean Goup estimator), badania wskazują, że fundusze strukturalne miały pozytywny wpływ w 33 podregionach (45%), nieistotny wpływ w 36 podregionach (49%) oraz negatywny w 4 podregionach (5%). Ponadto, wyniki analizy ekonometrycznej sugerują, że o efektywności polityki europejskiej nie decyduje wyłącznie pomoc udzielana subregionom. Istnieją jednostki NUTS 3, w których niższy niż przeciętny napływ środków przynosi pozytywne skutki, natomiast w niektórych przypadkach wysokie wsparcie negatywnie wpływa na wzrost gospodarczy. Wyniki zostały zweryfikowane przy wykorzystaniu różnych podejść ekonometrycznych.

Słowa kluczowe: Polska, polityka spójności, wzrost gospodarczy subregionów, różnorodne rezultaty.

JEL: R11, R12, R58

1. Introduction

Poland joined the European Union (EU), along with nine other Central and Eastern European (CEE) countries, in 2004. Due to its relatively low level of economic and social development, those of its NUTS 2 regions whose GDP per capita was less than 75% of the EU average were eligible for substantial financial assistance. Furthermore, this disparity in development levels was broadly characterised by a relatively wealthy west and an economically disadvantaged 'eastern wall' that comprised five NUTS 2 regions with a GDP per capita below 75% of the national average.[1]

Poland became eligible for EU Cohesion Policy (CP) programmes during the 2000–2006 planning period and has received EUR 12.8 billion in structural support since 2004 (Appendix, Table A.1). Poland has been the primary recipient of EU Structural Funds (SF), securing allocations of EUR 67.2 billion for 2007–2013 and EUR 77.6 billion for 2014–2022 (EC, 2007; 2014). This assistance varied from EUR 104 to EUR 397 p.c.p.a., depending on region, with a national average of EUR 191 (Appendix, Figure A.1). Significantly, Poland benefitted most from CP support, surpassing Spain, in 1989–2006.

The effectiveness of the Cohesion Policy (CP) has been extensively studied, although the findings have been mixed and inconclusive. Several empirical papers have questioned whether injecting funds into regional economies inevitably leads to economic growth (Ederveen et al., 2006; Cerqua & Pellegrini, 2018; Di Caro & Fratesi, 2022). Studies on the correlation between CP funds and growth in Poland conclude that the funds have a positive impact on growth, but an insignificant impact on convergence (Kozak, 2014; Piętak, 2021). This steady increase in structural support stands out as a notable aspect of the Polish economy. The results of the CP are observable in the expansion of expressways and motorways, as well as in overall wellbeing. This raises pertinent questions as to whether the EU's financial backing of the member state it subsidises most heavily yields diverse outcomes across NUTS 3 subregions, and if so, whether these results are linked to the levels of assistance provided.

The present study has two primary objectives. The first is to investigate the variation in CP outcomes across NUTS 3 subregions in Poland. The second is to evaluate whether the level of SF assistance influences the effectiveness of the CP. These objectives add to the academic discourse regarding the role of the CP in regional growth and convergence in the EU member state that benefitted most from it in 2007–2020.

Following Di Caro and Fratesi (2022), the econometric approach adopted in this study comprises two steps. In the first step, the Dynamic Mean Group (MG) model was utilised to assess the long-run relationship between economic growth and CP funds for each subregion. The second step employed the cross-section logit model to identify those factors that influence the effectiveness of the CP.

[1] NUTS 2 regions of Eastern Poland with their GDP per capita as a percentage of the national average in 2021: Lublin (68.7%), Subcarpathia (69.8%), Warmia-Masuria (70.8%), Świętokrzyskie (72.5%), and Podlachia (72.9%).

This analysis required a dataset that encapsulates the support allocated to each NUTS 3 subregion in Poland. The statistics provide information about the activities supported by CP at the gmina (municipal) level. For present purposes, all investments supported by SF were identified and allocated to their respective NUTS 3 subregions.

The originality of the present study is twofold. Firstly, to the best of the author's knowledge, it is the first attempt to assess the heterogeneous impact of the CP across Poland's NUTS 3 subregions. Moreover, the results of the econometric analysis enable these subregions to be classified on the basis of the effectiveness of the CP and the level of assistance they receive.

Secondly, the study identifies the factors that significantly influence the effectiveness of the CP, such as GDP per capita and the level of SF assistance. It therefore contributes to a better understanding of how EU policies can be optimised and targeted to achieve desired outcomes in Poland.

The structure of the study is as follows. Section 2 provides a concise literature review on the subject. Section 3 describes the data and the econometric methodology. Finally, Section 4 presents the conclusion and discusses the results.

2. Literature review

There is a wide range of empirical studies evaluating the impact of the CP on economic performance at both the regional and national levels. However, the empirical results are difficult to compare due to the different methodologies used and the periods covered (Hagen & Mohl, 2009; Marzinotto, 2012; Pieńkowski & Berkowitz, 2015). Recent papers confirm the positive relationship between European support and regional economic growth (Maynou et al., 2014; Di Cataldo, 2017; Fiaschi et al., 2017; Giua, 2017; Cerqua & Pellegrini, 2018; Di Caro & Fratesi, 2022). By contrast, earlier empirical analyses are less optimistic, and highlight the insignificant or conditional impact of CP on growth (Ederveen et al., 2006; Bähr, 2008; Esposti & Bussoletti, 2008; Le Gallo et al., 2011; Becker et al., 2012; Rodríguez-Pose & Novak, 2013; Antunes et al., 2020).

As the present study examines why a given policy yields results that are heterogeneous across Poland's subregions, the literature review is extensive. Dall'Erba and Fang (2017) emphasise that CP is more effective in Objective 1 regions.[2] Percoco (2017) contends that the CP has a stronger impact in regions with a less-developed service sector. Other researchers conclude that the CP is more effective in and around urban centres (Gagliardi & Percoco, 2017), in regions that have implemented a development policy (Cappelen et al., 2003), and in highly decentralised countries (Bähr, 2008). Bradley (2006) points out that multiplier effects in Spain and Poland are greatest in less developed regions. Finally, Crescenzi and Giua (2020) demonstrated that the CP is highly effective in the UK and Germany, but considerably less so in southern member states (e.g. Italy and Spain), due to the economic collapse of 2008.

[2] Objective 1 regions are those whose GDP per capita is less than 75% of the Community average.

Di Caro and Fratesi (2022) examined the heterogeneous results of the CP across NUTS 2 regions between 1990 and 2015. The authors focused solely on the financial resources of the European Regional Development Fund (ERDF), emphasising that this financial instrument is intended to support regional economic growth, which is not always the case with other funds. They found that the effectiveness of the CP in a given region does not always depend on the level of assistance given. The authors identify four groups of regions, including those characterised by trigger policies, low levels of assistance, and a positive impact on economic performance.

A recent study by Calegari et al. (2023) shows that any conclusion(s) about the effectiveness of the CP may be conditioned by the specification of the model. The effectiveness of the CP is more apparent when assessing the effect of SF on regional wellbeing than when assessing their effect on regional growth. The authors further contend that the positive impact of the CP on regional performance stems from its influence in Eastern regions. In the case of Western regions, this relationship is statistically insignificant.

Finally, Crucitti et al. (2023) use a dynamic spatial general equilibrium model to assess the macroeconomic effect of the CP in the EU from 2007 to 2017. Their empirical analysis confirms the positive and statistically significant relationship between CF programmes and macroeconomic variables (e.g. imports, exports, investment). Again, the results confirm that CEE is the main beneficiary, but the CP also has a positive impact in more developed countries over the long term.

Heterogeneous CP results have also been observed in Poland. Cieślik and Rokicki (2013) assess the influence of SF in Poland in 2004 to 2006. The study finds that the CP had a positive impact on growth and employment in all regions, but that poorer regions benefitted most. As for the heterogeneous effect of the CP in diminishing development gaps, Czudec et al. (2019) examine five economically less developed NUTS 2 regions in Eastern Poland. Their study shows the positive role of the CP in reducing the regional transport accessibility gap while observing a simultaneous increase in the innovation gap. Gorzelak and Przekop-Wiszewska (2021) emphasize that EU programs primarily affect the 'civilizational' aspects of socio-economic life at the local level. Finally, Biedka et al. (2021) demonstrate that CP-funded investment in human capital positively affects local revenues in Polish municipalities. However, the authors note that the positive effect is stronger in structurally burdened areas and weaker in rural and metropolitan regions.

In summary, the literature review confirms that the CP has a positive impact on regional performance. However, the strength of this impact might be contingent on several factors, such as regional development level, level of decentralization, or the structure of regional economies.

3. Empirical analysis

3.1. Data

The annual data used in this study were obtained from the following sources: Statistics Poland's Local Data Bank database for data on Poland's NUTS 3 subregions; and the Ministry of Development Funds and Regional Policy for its published list of investments co-financed by the CP in Poland. All the regressors used in the study were transformed into logarithmic values. The log-log case provides direct estimates of the elasticities of the regressors. The first stage of the econometric analysis uses two variables: subregional GDP per capita (*GDPpc*) is the dependent variable, and the covariate (*Fund*) represents the annual average value of SF per capita in current prices (in euros). The second stage uses several regressors that are available at the NUTS 3 level and which have been deemed relevant by scholarly papers.

Scholars have emphasized the positive roles of agglomeration in terms of the growth of an average-sized city for productivity growth (Fujita & Thisse, 2002; Castells-Quintana & Royuela, 2014; OECD, 2016; Frick & Rodríguez-Pose, 2016). The analysis uses two variables to represent agglomeration: population density (*Dens*) measures the number of people per sq. km.; and big city (*Bigcity*) is a binary variable with a value of 1 if a city has a population greater than 250,000 and 0 otherwise.[3] The covariates related to the proportional contribution of various sectors of the economy to gross value added (GVA) are also covered by the econometric analysis, which has also been applied by authors who study the factors that influence regional growth (e.g. López-Bazo et al., 2004; Rodríguez-Pose et al., 2012).

Table A.2 presents the variables included in the models, along with their definitions and sources of extraction (see Appendix). Table A.3 provides descriptive statistics for the covariates. The focus is on the dependent variable and the SF regressor. The mean GDP per capita in Poland's NUTS 3 subregions is 12,755 EUR, with a maximum of 40,438 EUR in Warsaw, and a minimum of 7,424 EUR in the Przemyśl subregion. The mean CP support is 191 EUR p.a. The Tri-City (Gdańsk/Gdynia/Sopot) subregion receives the largest allocation (398 EUR) and the Nowy Targ subregion the smallest (104 EUR).

Table A.4 depicts the correlation matrix between the regressors applied in the study. There is a positive correlation between the dependent variable and regressors such as structural funds (0.30), population density (0.84), or the urban proportion of the population (0.67). There is also a positive relationship between the dependent variable and such covariates as the service sector's proportional contribution to subregional GVA (0.40) and the number of subregional populations (0.67). There is a negative correlation, however, between the dependent variable and the

[3] Between 2007 and 2020, there were sixteen cities in Poland with populations greater than 200,000: Warszawa (Warsaw) (1,792,718), Kraków (780,796), Łódź (667,923), Wrocław (641,201), Poznań (530,464), Gdańsk (470,633), Szczecin (396,472), Bydgoszcz (341,692), Lublin (337,788), Białystok (296,401), Katowice (289,162), Gdynia (244,104), Częstochowa (215,905), Radom (208,091), and Rzeszów (198,476).

regressors *Agri* (–0.47) and *Indust* (–0.19), which represent the proportional contributions of the agricultural and industrial sectors to subregional GVA. Multicollinearity is tested using the Variance Inflation Factor (VIF). However, as all values are less than 10, this is not a concern.

3.2. Econometric models

The econometric analysis comprises two steps. The first involves determining the long-run relationship between CP support and subregional economic performance using the Vector Error Correction Model (VECM). The second involves identifying the factors that determine the effectiveness of EU policy. The foregoing analysis of the literature led to two hypotheses being formulated when designing the study:

Hypothesis 1 (H1): *The impact of the CP in Poland in 2007–2020 was positive, and poorer regions benefitted most.*

Hypothesis 2 (H2): *The effectiveness of the CP in a subregion does not always depend on the amount of the allocation. Subregions allocated lesser amounts sometimes improve more.*

As the econometric procedure is based on panel data, several tests had to be conducted in order to find the correct approach. First, the cross-sectional dependence across units of the panel was tested. These tests rejected the null hypothesis of weak cross-section dependence, thereby confirming the occurrence of serial correlation across units (Appendix, Table A.5). Second, the Blomquist and Westerlund (2013) test was used to test the slope homogeneity in a panel with serial correlation. The null hypothesis of slope homogeneity was rejected, indicating that heterogeneous panel estimation techniques, such as Mean Group family models, should be applied (Appendix, Table A.6). Third, the panel was also tested for structural breaks. As the Ditzen, Karavias, and Westerlund (2021) test revealed structural breaks in 2011 and 2016 (refer to the Appendix, Table A.7), time dummy variables were added to the model.

The first step of the econometric analysis encompassed two variables: GDP per capita as the dependent variable and SF as the regressor. The CIPS panel unit root test was used in the case of heterogeneous panels with cross-sectional dependence (Pesaran, 2007). The results indicate that GDP per capita is stationary at level I(0), while the SF are stationary at the first difference I(1). The panel data series are therefore stationary at mixed order (Appendix, Table A.8). Subsequently, the Westerlund (2007) test was used to detect cointegration. The results confirmed the existence of a long-run relationship between regional GDP per capita and SF (Appendix, Table A.9).

The results of the panel unit root tests and the cointegration test decided the use of a Vector Error Correction Model (VECM) to define the long-run relationship between the dependent variable and the regressors. The generalised ARDL model is described by the equation (Pesaran and Smith, 1995):

$$y_{it} = \sum_{j=1}^{p} \delta_i y_{i,t-j} + \sum_{j=0}^{q} \beta'_{ij} X_{i,t-j} + \varphi_i + e_{it} \tag{1}$$

where:
y_{it} – the dependent variable,
δ_{it} – the coefficient of the lagged dependent variable,
$X_{i,t-j}$ – a vector of control variables,
p and q – the lags of the dependent and independent variables (optimal lag orders), respectively,
φ_i – the unit specific fixed effect,
e_{it} – the error term.

The VECM model is specified as:

$$\Delta y_{it} = \theta_i \left[y_{i,t-1} - \lambda'_i X_{i,t} \right] + \sum_{j=1}^{p-1} \xi_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \beta'_{ij} \Delta X_{i,t-j} + \varphi_i + e_{it} \quad (2)$$

where:
$\theta_i = -(1-\delta_i)$ – the group specific speed of adjustment coefficient, which is expected to be negative ($\theta_i < 0$),
the term $\boldsymbol{\lambda'_t}$ represents the vector of long run relationship,
$ECT = \left[y_{i,t-1} - \lambda'_i X_{i,t} \right]$ denotes the error correction term,
the coefficients ξ_{ij} and β'_{ij} represent the short run-dynamic coefficients.[4]

This version of the ARDL model (Equation 2) uses a different operator for the dependent variable, in which the lags of the dependent and independent variables are reduced by 1 (p minus 1 and q minus 1, respectively). This adjustment reduces the number of lags in the model. The ARDL (1, 0) model was chosen on the basis of Akaike (AIC) and Schwarz (SC) information criteria. The speed of adjustment, denoted as θ_i, represents the rate at which the group converges to long-run equilibrium, and the error correction term (ECT) incorporates long-run information into the model.

For the purpose of empirical analysis, Equation 2 is restricted to the main regressor (*Fund*) and also covers the time dummy variables for 2011 and 2016. After adding a trend to the time series, the modified model takes the form:

$$\Delta y_{it} = \theta_i \left[y_{i,t-1} - \lambda_{1i} Fund_{i,t} \right] + \lambda_{21} \Delta Fund_{i,t} + dummy2011 + dummy2016 + trend + e_{it} \quad (3)$$

Equation 3 is focused on the long-run relationship between growth and funds (λ_{1i}). The Hausman test enables the dynamic Mean Group estimator (MG), the Pooled Mean Group estimator (PMG), and the Dynamic Fixed Effect estimator (DFE) to be compared (Ditzen, 2018). As only the dynamic MG estimator ensures the acquisition of long-run effects for each unit, this is the one that was applied in the study. Comparing the MG and PMG estimators the prob-value is $q = 0.047$, which suggests that the MG estimator is more appropriate for the data. In turn, the Hausman test also shows that the PMG estimator is more appropriate than the DFE estimator ($q = 0.0000$).

[4] The parameter 'θ_i' must be negative and statistically significant to indicate a return to long-run equilibrium.

The second stage of the econometric approach employs a cross-section Logit model. Estimations from Equation 4 allow for an assessment of the factors influencing the effectiveness of the CP in Poland's NUTS 3 subregions. The Logit model takes the form:

$$effect_i = \alpha_i + \beta X_i + e_i \tag{4}$$

The variable $effect_i$ is a binary variable. It takes a value of one in the case of a positive and statistically significant coefficient of regressor *Fund* in Equation 3, and zero otherwise. The set of regressors βX_i encompasses covariates at the NUTS 3 level. The main reason for choosing the Logit model in the second stage of the econometric analysis is twofold. First, the dependent variable (dummy variable) allows for categorically distinguishing regions of positive or nonpositive effect. Second, the set of regressors covered by the model enables a better understanding of the factors that decide the effectiveness of the CP.

3.3. Results

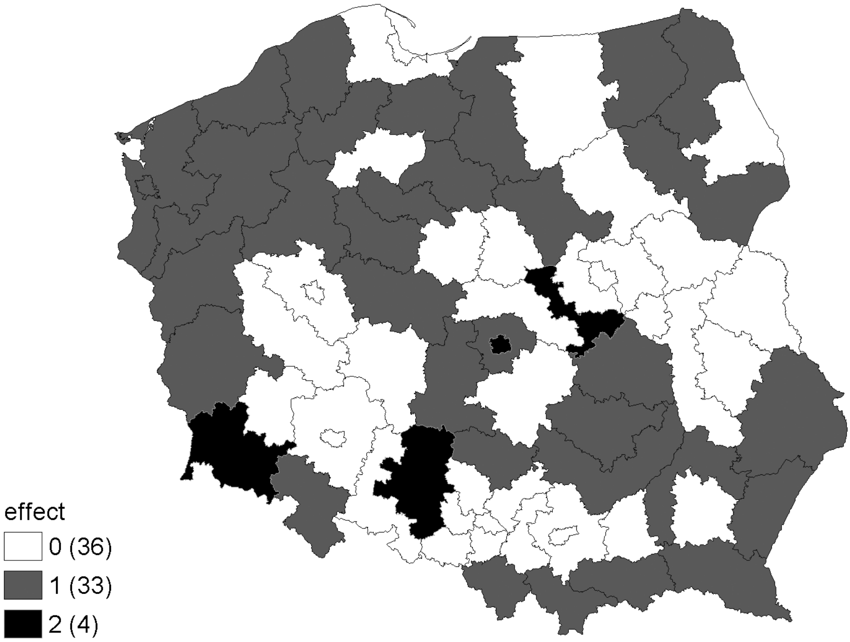
3.3.1. The impact of the CP on the growth of NUTS 3 subregions

This part describes the results derived from the first stage of the econometric analysis of the relationship between GDP per capita and SF in NUTS 3 subregions in Poland. Table A.10 presents the estimates of Equation 3 for all units of the panel (see Appendix). The speed of adjustment, θ_i, *is* –1.189 (q=0.000), i.e. GDP per capita returns to equilibrium after 8 months in the event of a shock. The long-run effect of the CP is positive and statistically significant (0.016) at the 1% significance level, suggesting that a 1% increase in structural funds causes a 0.016% increase in GDP per capita. The variables *trend* and *time dummy* are also statistically significant.

Table A.11 presents the results for all subregions, indicating whether the CP has a positive, insignificant, or negative impact on each subregional economy (see Appendix). The results suggest that the CP had a positive impact on 33 subregions (45%), an insignificant impact on 36 subregions (49%), and a negative impact on 4 subregions (5%). Furthermore, statistically significant coefficients in the long-run relationship between CP subsidies and growth were observed in 51% of the subregions.

Figure 1 illustrates the impact of the CP on subregional growth. Its effectiveness does not follow any clearly defined pattern, although some trends are apparent. Subregions exhibiting a positive impact are concentrated in the northwest of the country. The CP has an insignificant impact in subregions surrounding metropolitan areas such as Warsaw, Wrocław, or Poznań. The relationship was negative in the Jelenia Góra, Opole, Stargard, and Łódz subregions. Significantly, effectiveness, as measured by increase in GDP per capita, is not clearly delineated between the poorer Eastern regions and the wealthier Western ones.

Figure 1.
Effects of the Cohesion Policy across NUTS 3 subregions in Poland from 2007 to 2020

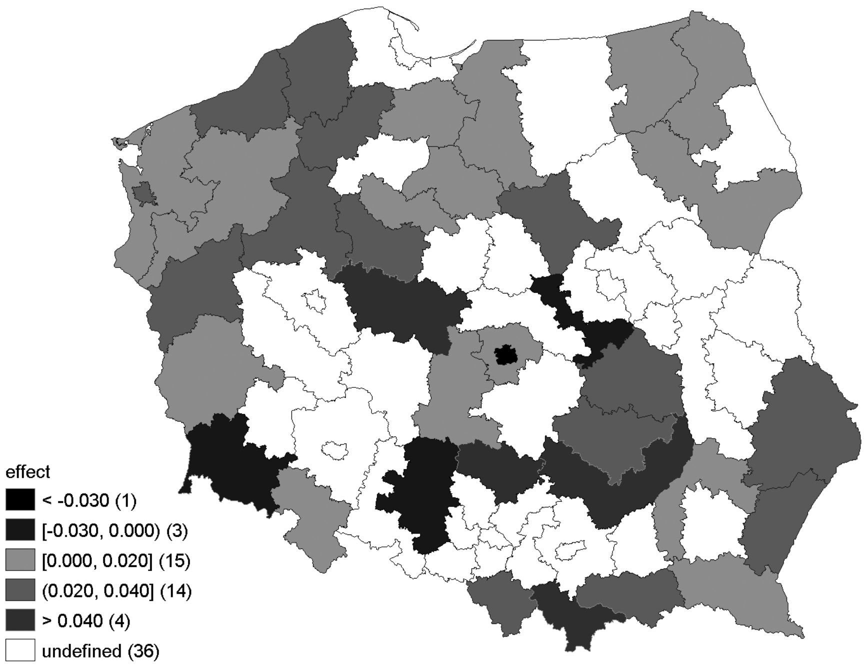


Note: in the map: white subregions indicate an insignificant impact; grey subregions represent a positive impact; black subregions denote a negative impact. In the case of positive and negative impacts, the parameter θ_i is negative and statistically significant at the 5% significance level.

Source: own elaboration based on the author's modelling simulations.

Figure 2 presents the results of the estimated coefficient of Equation 3 for each subregion. The highest positive impact was registered in the Częstochowa (0.054), Sandomierz-Jędrzejów (0.046), and Konin (0.042) subregions. Fifteen subregions recorded a positive effect between 0.00 and 0.02, and fourteen recorded a positive effect between 0.02 to 0.04. The coefficient has its greatest negative values in Łódź (-0.051) and Opole (-0.0323). It is estimated that, on average, a 1% increase in CP raises subregional GDP per capita by approx. 0.022%. These results differ from those of other studies, which estimate an increase in GDP per capita of 0.05–0.07% for NUTS 2 regions (Dall'Erba & Fang, 2017; Di Carro & Fratesi, 2022). These differences might be explained by the different tiers of regional division or different time spans considered.

Figure 2.
Estimated coefficients from Equation 3



Source: own elaboration based on the author's modelling simulations.

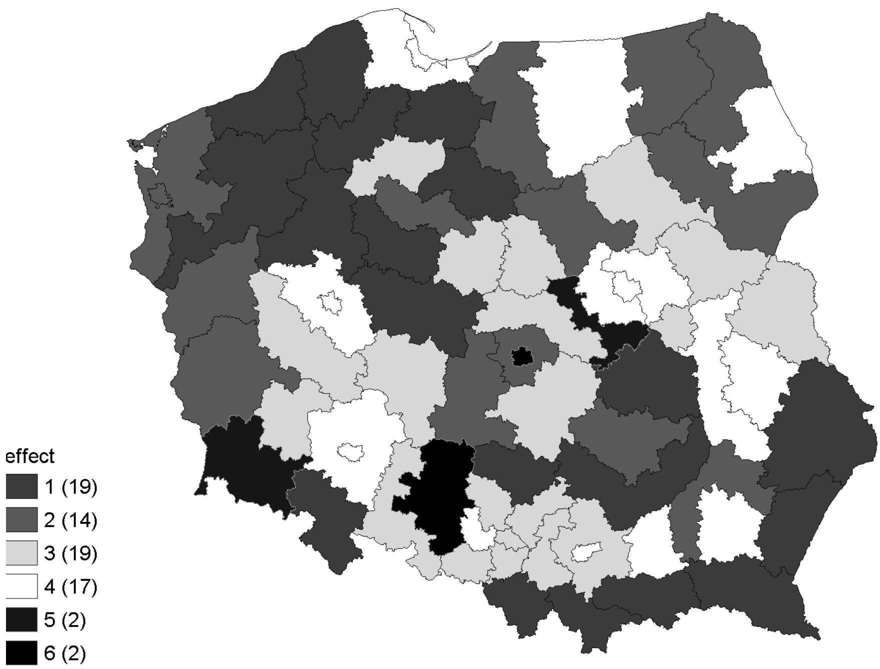
Figure 3 illustrates the impact of the CP for a given SF allocation. Subregions are categorized into two groups: one whose support level is greater than or equal to the national average (EUR 191); and the other whose support is less than that. Combining the heterogeneous effects of the CP and the level of assistance resulted in the identification of six groups of subregions. Subregions where the effect of the CP was positive are marked white, those where the CP was statistically insignificant are marked grey, and those where the effect of the CP was negative impact are marked black. Furthermore, the colour intensity corresponds to the level of assistance, distinguishing between low and high levels.

The CP was effective in the first two groups. There are 19 subregions where the CP had a positive impact, despite receiving a low level of assistance. The coefficient had its largest positive values in the Częstochowa, Sandomierz, and Konin subregions. The CP had a positive impact in 14 subregions that had a lot of assistance, e.g. Szczecin, Ciechanów, and Gorzów. Two of the four subregions where the CP had a negative impact received a high level of assistance (Łódź and Opole); the other two (Jelenia Góra and Żyrardów) received allocations below the national average.

The econometric analysis reveals a significant number of subregions where the level of assistance had an insignificant impact on subregional economic performance. In these cases, the CP is deemed ineffective or, in the case of low assistance, marginally effective. The impact of the CP was insignificant in 4 cities with populations over 500,000 that received a high level of assistance (Warsaw, Wrocław, Poznań, Kraków, and the Tri-City). The impact of the CP was insignificant in the 5 subregions surrounding these cities, despite their receiving a high level of assistance. The impact was only insignificant in one subregion (Kraków) that received a low level of assistance. The CP had a positive impact in the Łódź subregion, which received a high level of assistance.

Figure 3.

Heterogeneous results of the CP and varying levels of assistance in Polish NUTS 3 subregions



Note: 1 – positive impact and low level of assistance; 2 – positive impact and high level of assistance; 3 – insignificant impact and low level of assistance; 4 – insignificant impact and high level of assistance; 5 – negative impact and low level of assistance; 6 – negative impact and high level of assistance.

Source: own elaboration based on the author's modelling simulations.

3.3.2. The key factors influencing the effectiveness of the CP

The second stage of the econometric analysis sought to identify the primary factors impacting the effectiveness of the CP in NUTS 3 subregions. Table 1 displays the outcomes derived from Equation 4, employing the cross-section Logit model with robust standard errors. The selection of covariates was influenced by economic literature and constrained by the availability of subregional data. Data at the NUTS 3 level are more limited than those at the broader NUTS 2 level. This obviously restricts the breadth of the econometric analysis.

Table 1.

Results of the cross-section Logit model (coefficients)

	Dep. variable: 1 if positive and significant effect from the Equation 4; otherwise 0			
	1	2	3	4
Const	41.6033*** (11.3725)	41.6168*** (11.9783)	55.5244*** (15.8836)	62.2476*** (17.3715)
GDPpc	−4.4669*** (1.2190)	−4.3872*** (1.2433)	−4.9872*** (1.5848)	−5.3351*** (1.6395)
Fund		−0.5321 (0.8375)	−0.8650 (0.8632)	−1.2565 (0.8826)
Dens			0.6177 (0.5232)	0.9429 (0.6891)
Cityproc			2.4176* (1.1174)	2.2255* (1.1360)
Agri				−0.0446 (0.1216)
Bigcity				1.3845 (1.1299)
Observations	73	73	73	73
N	73	73	73	73
Wald chi2	13.43	13.41	14.41	14.59
chi2	0.0002	0.0012	0.0061	0.0237
Pseudo R2	0.1776	0.1810	0.2500	0.2500

Note: robust standard errors in parentheses; *q < 0.05 denotes significance at the 5% level; **q < 0.01 denotes significance at the 1% level; and ***q < 0.001 denotes significance at 0.1% level.

Source: own elaboration based on the author's modelling simulations.

The results confirm that the CP is more likely to have a positive impact in poorer subregions, as GDP per capita (*GDPpc*) consistently shows a negative and statistically significant relationship. The relationship between the level of assistance and the effectiveness of EU support, however, reveals that increasing the amount (*Fund*) allocated to a given subregion does not increase the likelihood of a positive impact, i.e. the relationship is statistically insignificant.

Covariates related to agglomeration are included in order to explain the heterogeneous results of the CP. Population density (*Dens*) has a positive but statistically insignificant effect, indicating that more densely populated subregions are not more likely to benefit from the CP. Additionally, the dummy variable of cities with a population of over 250,000 (*Bigcity*) is positive but again statistically insignificant.

The proportion of the population that is urban (*Cityproc*) is positive and statistically significant. The probability of there being a positive relationship between the CP and subregional GDP per capita is greater in those subregions with proportionally large urban populations.

The remaining variables pertain to the subregional economic structure, specifically the proportional contribution of the agricultural sector (*Agri*) to GVA. The results show that increasing *Agri* does not increase the likelihood that the CP will have a positive impact on subregional GDP per capita.

3.4. Robustness check

Several modifications were made to the ARDL model used in the first step of the econometric analysis in order to test the robustness of the results. These modifications involved including the time lags for both the dependent and independent variables (2,2), and replacing the dependent variable by subregional GDP. These modifications led to different results concerning the impact of the CP in seven subregions (Appendix, Table A.11, Column 4). The impact of the CP changed from positive to insignificant in the Bielsko-Biała, Szczecineko-Pyrzyce, Zielona Góra, Starogard Gdański, Krosno, and Suwalki subregions, and from insignificant to negative in Wrocław.

As for the covariates: the structural funds variable (*Fund*) was replaced by the variable *Fundproc*, which is the proportion of SF in subregional GDP; population density was replaced by subregional population (*Popul*); and the proportional contribution of agriculture to GVA was replaced by two other variables related to the industry or service sector in subregional GVA.

Table 2 presents the relevant results of Equation 4, after the insertion of this new set of covariates. These findings reaffirm that the CP is not more likely to have a positive impact when GDP or assistance level is high. GDP is negative and statistically significant and SF is statistically insignificant.

The positive and statistically significant value of *Popul* indicates that the more populated subregions, with a greater potential market, are more likely to register a positive relationship between CP subsidies and subregional GDP. Other variables related to the proportional contributions of various sectors in the subregional economy to GVA yield insignificant results.

Finally, the Dumitrescu-Hurlin (2012) panel causality tests were used to determine the direction of causality between the two main covariates, viz. *GDPpc* and *Fund*. The results indicate that there is a unidirectional long-run relationship between them. *Fund* does Granger-cause GDPpc for at least one panel, but GDPpc does not establish a long-run relationship (see Appendix, Table A.11).

Table 2.
Results of the cross-section Logit model: Robustness check (coefficients)

	Dep. variable: 1 if positive and significant effect from the Equation 4; otherwise 0			
	1	2	3	4
Const	33.2671*** (11.9023)	30.4555*** (12.4838)	45.9798*** (15.2248)	48.1401*** (17.3824)
GDP	–1.5069*** (0.5298)	–1.4053*** (0.5475)	–4.5322*** (1.5492)	–4.4858*** (1.6272)
Fundproc		1.0248 (1.2701)	–0.2176 (1.4844)	–0.2380 (1.4617)
Popul			4.1261* (2.0138)	4.5492* (2.1927)
Cityproc			2.3160 (1.9795)	1.3067 (1.1647)
Industr				–0.3356 (2.0228)
Service				0.7117 (2.6312)
Observations	73	73	73	73
N	73	73	73	73
Wald chi2	8.09	8.94	13.74	14.76
chi2	0.0045	0.0114	0.0082	0.0222
Pseudo R2	00936	0.0999	0.1380	0.1430

Note: robust standard errors in parenthesis: *q < 0.05 denotes significance at the 5% level; **q < 0.01 denotes significance at the 1% level; and ***q < 0.001 denotes significance at the 0.1% level.

Source: own elaboration based on the author's modelling simulations.

4. Discussion and Conclusion

This study investigates whether the CP yields heterogeneous results across NUTS 3 subregions in Poland and determines which factors play a decisive role in the effectiveness of funding in fostering economic growth. The two-stage econometric analysis confirms hypotheses H(1) and H(2), and leads to the following conclusions.

First, the outcomes of the dynamic MG model show that SF may have a positive, insignificant, or even negative impact on subregional economic performance. However, in the most statistically significant cases, the econometric analysis confirms a positive relationship between CP support and subregional growth.

Second, the results of the Logit model indicate that the effectiveness of the CP does not necessarily depend on the level of assistance. The impact of the CP may be negative in subregions that receive allocations greater than the national average and positive in subregions that receive allocations less than the national average. The results also reveal that the effectiveness of EU support is influenced by other factors. The CP is not likely to have a positive impact in more developed subregions.

Additionally, a proportionally greater urban population or a larger potential market (proxied by population) increases the likelihood that the CP will have a positive effect.

The econometric analysis shows that the CP has a positive and significant impact on subregional GDP per capita in 36 Polish subregions (49%). These results are more optimistic than the estimates of Di Carro and Fratesi (2022), who found a statistically insignificant impact in 10 Polish NUTS 2 regions (63%). However, that study only considered EFRR funds, while the present study encompasses all financial support provided by the CP. Additionally, the longer time span of Di Carro and Fratesi's analysis, starting from 2000, may account for the different estimates.

The econometric analysis found a negative relationship between CP subsidies and growth in four subregions. Di Carro and Fratesi (2022) found a negative effect in only one region (Abruzzo, Italy), and they attributed this to a climatic catastrophe. However, this negative effect disappeared when the time span was changed. The negative impact of investments is not an unknown issue in development theory and is explained by economic growth models. Both Uzawa (1965) and Lucas (1988) show that an improper relationship between public and private capital may adversely impact development. Additionally, scholars have found that public investment does not significantly impact regional growth in the richest regions (Bajo-Rubioet al., 1999).

Scholars have also attempted to calculate the ratio of SF assistance to regional GDP that optimises economic performance. However, the results are inconclusive and vary depending on time span and sample data. Becker et al. (2012) identified a threshold of 1.8% for EU-15 regions in 1994–1999, beyond which the funds have no significant impact. By contrast, Fiaschi et al. (2017) estimated a threshold of 3.0% for 175 EU-12 Objective 1 regions in 1991–2008. The present study finds that a ratio of 1.7% results in the CP having a positive impact on Poland's subregions, while ratios of 1.5% and 1.3% result in insignificant and negative impacts respectively. The differences between the three groups of regions are rather small, and the proportional contribution of SF to subregional GDP might not be a decisive factor in the effectiveness of the CP.

Furthermore, Poland's large cities constitute a group of subregions where the impact of the CP is insignificant, despite their receiving the greatest level of assistance. The impact of the CP is likewise insignificant in those subregions that surround metropolitan areas, even though they receive allocations above the national average. This raises questions about the equitableness of EU regional support; questions that should be addressed by policymakers. The present study lends itself to the recommendation that regional policy should be focused on less developed areas, where it is more effective.

As for further research, it is important that the factors that contribute to the negative impact of the CP in the four subregions be identified and examined. Analyses conducted at the lowest regional administrative divisional level (i.e. at the municipal level) might reveal the underlying causes. This will be challenging due to data limitations at this level. However, empirical analyses may highlight specific areas within these subregions that play a decisive role in the negative relationship between CP subsidies and economic performance. Besides, the econometric analysis encompasses all structural funds allocated to Polish subregions. Other authors have em-phasised that the ERDF is the primary financial instrument impacting economic growth. Future studies should consider disaggregating the analysis of SF in order to gain a more nuanced understanding.

The results of the present study are subject to several limitations and caveats. The data at the NUTS 3 level are not as extensive as those at the NUTS 2 level. This deficiency of data hampers the econometric analysis, and consequently prevents any other factors that might influence the effectiveness of the CP from being identified. Moreover, the choice of time span and econometric approach is critical. Constricting the time frame or increasing the number of observations to the NUTS 4 level might well lead to different conclusions.

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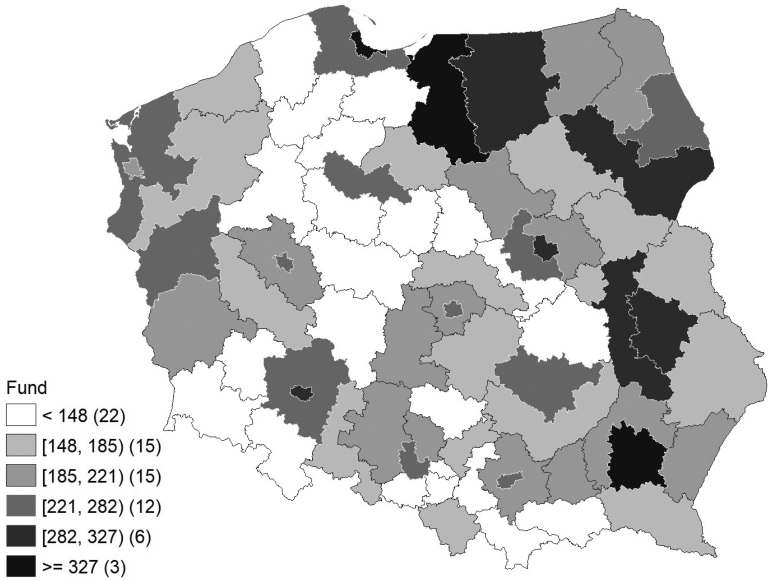
Appendix

Figure A1.
Structural funds allocated to Polish NUTS 3 subregions from 2007 to 2020 (EUR per capita)



Note: the EUR per capita values (Fund) express the annual amount of funds allocated per head of subregional population.

Source: own calculations based on the data provided by The Ministry of Development Funds and Regional Policy, www. https://mapadotacji.gov.pl/

Table A1.
Cohesion Policy in Poland from 2004 to 2020

	Cohesion Policy		
	Total value (EUR billion)	Per capita (EUR)	Percentage of the CP
2004–2006	12.8	105.9	3.5%
2007–2013	67.2	251.7	19%
2014–2020	77.6	291.4	22%

Note: the total value of the Cohesion Policy (CP) includes the financial resources of structural funds (SF) and the Cohesion Fund.

Source: European Commission (2007, 2014).

Table A2.
The set of regressors entered in the econometric models

Variable	Marking	Description	Source of data
Gross domestic product (GDP) per capita	*GDPpc*	The logarithm of the initial value of GDP per capita	Local Data Bank, Statistics Poland (GUS)
Structural funds (SF)	*Fund*	The logarithm of the annual average value of structural funds per capita	Ministry of Development Funds and Regional Policy
Population Density	*Dens*	The logarithm of the number of people per square kilometre	Local Data Bank, Statistics Poland (GUS)
Share of urban population	*Cityproc*	The logarithm of urban population	Local Data Bank, Statistics Poland (GUS)
Agricultural sector	*Agri*	The logarithm of the proportional contribution of the agricultural sector to subregional gross value added (GVA).	Local Data Bank, Statistics Poland (GUS)
Industry sector	*Indust*	The logarithm of the proportional contribution of the industrial sector to subregional GVA.	Local Data Bank, Statistics Poland (GUS)
Service sector	*Service*	The logarithm of the proportional contribution of the service sector to subregional GVA.	Local Data Bank, Statistics Poland (GUS)
Number of population	*Popul*	The logarithm of the population of the subregion	Local Data Bank, Statistics Poland (GUS)
Big cities	*Bigciy*	A dummy binary variable. It takes a value of 1 if a subregion has a city with a population of at least 250,000 and 0 otherwise.	Statistics Poland (GUS)

Source: own elaboration.

Table A3.
Descriptive statistics

Variable	Obs	Mean	Std.dev.	Min	Max
GDPpc	1023	12754.57	5148.16	7424.18	40438.37
Fund	1023	191.50	62.73	104.24	397.62
Dens	1023	359.73	679.11	41.0	3462.0
Cityproc	1023	0.56	0.198	0.226	1.0
Agri	1023	4.20	3.506	0.030	13.95
Indust	1023	28.96	8.743	9.180	56.69
Service	1023	58.54	9.267	32.70	84.14
Popul	1023	522982.7	219391.3	183929.8	1861184.0

Source: the author's computation based on Statistic Poland (GUS) and Local Data Bank, Statistics Poland (GUS) datasets.

Table A4.
Correlation matrix

	GDPpc	Fund	Dens	Cityproc	Agri	Indust	Service	Popul
GDPpc	1.0000							
Fund	0.3054	1.0000						
Dens	0.8465	0.3751	1.0000					
Cityproc	0.6733	0.3187	0.7534	1.0000				
Agri	-0.4764	-.02213	-0.4750	-0.5577	1.0000			
Indust	-0.1917	-0.3896	-0.4771	-0.2722	-0.0089	1.0000		
Service	0.4056	0.4776	0.6689	0.5149	-0.3653	-0.9134	1.0000	
Popul	0.6741	0.3501	0.6279	0.3911	-0.4807	-0.2905	0.4650	1.0000

Source: the author's computation based on Statistic Poland (GUS) and Local Data Bank, Statistics Poland (GUS) datasets.

Table A5.
Cross sectional dependence test

	CD
GDPpc	185.63 (0.0000)
Fund	41.04 (0.0000)

Note: q-values in parenthesis, CD based on Pesaran (2015, 2021).

Source: the author's computation based on Statistic Poland (GUS) and Local Data Bank, Statistics Poland (GUS) datasets.

Table A6.
Blomquist and Westerlund (2013) slope homogeneity test

	Delta	q-value
	-2.645	0.008
adj.	-3.179	0.001

Source: the author's computation based on Statistic Poland (GUS) and Local Data Bank, Statistics Poland (GUS) datasets.

Table A7.
Structural breaks test

		Bai & Perron Critical Values		
	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
F(1/0)	721.77	12.29	8.58	7.04
F(2/1)	443.99	13.89	10.13	8.51
Detected numbers of breaks		2	2	2
#	Index	Date	[95% Conf. Interval]	
1	5	2011	2010	2012
2	10	2016	2015	2017

Source: the author's computation based on Statistic Poland (GUS) and Local Data Bank, Statistics Poland (GUS) datasets.

Table A8.
Panel unit root test, CIPS

Variable	Intercept		Intercept + trend	
	I(0)	I(1)	I(0)	I(1)
DGPpc	-2.218**	-3.320***	-2.612**	-3.400***
Fund	0.330	-1.438	-2.064**	-2.947***

Note: an asterisk indicates the significance of the coefficients in the tables, where *, ** and *** denote 5%, 1% and 0.1% significance levels, respectively.

Source: the author's computation based on Statistic Poland (GUS) and Local Data Bank, Statistics Poland (GUS) datasets.

Table A9.
Westerlund (2007) cointegration test

Statistic	Value	Z-value	P-value	Robust P-value
Gt	-4.443	-21.832	0.000	0.000
Ga	-12.319	-0.386	0.350	0.041
Pt	-34.239	-18.513	0.000	0.004
Pa	-11.860	-4.080	0.000	0.045

Source: the author's computation based on Statistic Poland (GUS) and Local Data Bank, Statistics Poland (GUS) datasets.

Table A10.
The estimates of Equation 3, ARDL VECM model (1.1.)

D.GDPpc	Coefficient	Std. err.	z	P > /z/	[95% conf. interval]	
_ec						
Fund	0.0167	0.0037	4.50	0.000	0.0094	0.0240
SR						
_ec	-1.189	0.0267	-44.54	0.000	-1.242	-1.137
Fund						
D1.	-0.0007	0.0003	-2.29	0.022	-0.0014	-0.0001
dummy2011	-0.0515	0.0035	-14.70	0.000	-0.0583	-0.0446
dummy2016	-0.0540	0.0025	-20.98	0.000	-0.0591	-0.0490
trend	0.0503	.0035	14.27	0.000	0.0434	0.0572
_cons	7.824	0.6455	12.12	0.000	6.559	9.089

Source: own modelling simulations.

Table A11.
Effects of the Cohesion Policy across NUTS 3 subregions in Poland in 2007–2020

Num.	ID	Subregion	Effect on GDPpc	Effect on GDP
1	PL213	M. Kraków	insignificant	insignificant
2	PL214	Krakowski	insignificant	insignificant
3	PL217	Tarnowski	insignificant	insignificant
4	PL218	Nowosądecki	positive	positive
5	PL219	Nowotarski	positive	positive
6	PL21A	Oświęcimski	insignificant	insignificant
7	PL224	Częstochowski	positive	positive
8	PL225	Bielski	positive	**insignificant**
9	PL227	Rybnicki	insignificant	insignificant
10	PL228	Bytomski	insignificant	insignificant
11	PL229	Gliwicki	insignificant	insignificant
12	PL22A	Katowicki	insignificant	insignificant
13	PL22B	Sosnowiecki	insignificant	insignificant
14	PL22C	Tyski	insignificant	insignificant
15	PL411	Pilski	positive	positive
16	PL414	Koniński	positive	positive
17	PL415	M. Poznań	insignificant	insignificant
18	PL416	Kaliski	insignificant	insignificant
19	PL417	Leszczyński	insignificant	insignificant
20	PL418	Poznański	insignificant	insignificant

Num.	ID	Subregion	Effect on GDPpc	Effect on GDP
21	PL424	M. Szczecin	positive	positive
22	PL426	Koszaliński	positive	positive
23	PL427	Szczecinecko-pyrzycki	positive	**insignificant**
24	PL428	Szczeciński	positive	positive
25	PL431	Gorzowski	positive	positive
26	PL432	Zielonogórski	positive	**insignificant**
27	PL514	M. Wrocław	insignificant	**negative**
28	PL515	Jeleniogórski	negative	negative
29	PL516	Legnicko-głogowski	insignificant	insignificant
30	PL517	Wałbrzyski	positive	positive
31	PL518	Wrocławski	insignificant	insignificant
32	PL523	Nyski	insignificant	insignificant
33	PL524	Opolski	negative	negative
34	PL613	Bydgosko-toruński	positive	positive
35	PL616	Grudziądzki	positive	positive
36	PL617	Inowrocławski	positive	positive
37	PL618	Świecki	insignificant	insignificant
38	PL619	Włocławski	insignificant	insignificant
39	PL621	Elbląski	positive	positive
40	PL622	Olsztyński	insignificant	insignificant
41	PL623	Ełcki	positive	positive
42	PL633	Trójmiejski	insignificant	insignificant
43	PL634	Gdański	insignificant	insignificant
44	PL636	Słupski	positive	positive
45	PL637	Chojnicki	positive	positive
46	PL638	Starogardzki	positive	**insignificant**
47	PL711	M. Łódź	negative	negative
48	PL712	Łódzki	positive	positive
49	PL713	Piotrkowski	insignificant	insignificant
50	PL714	Sieradzki	positive	positive
51	PL715	Skierniewicki	insignificant	insignificant
52	PL721	Kielecki	positive	positive
53	PL722	Sandomierski-jędrzejowski	positive	positive
54	PL811	Bialski	insignificant	insignificant
55	PL812	Chełmiński-zamojski	positive	positive
56	PL814	Lubelski	insignificant	insignificant

Num.	ID	Subregion	Effect on GDPpc	Effect on GDP
57	PL815	Puławski	insignificant	insignificant
58	PL821	Krośnieński	positive	**insignificant**
59	PL822	Przemyski	positive	positive
60	PL823	Rzeszowski	insignificant	insignificant
61	PL824	Tarnobrzeski	positive	positive
62	PL841	Białostocki	insignificant	insignificant
63	PL842	Łomżyński	positive	positive
64	PL843	Suwalski	positive	**insignificant**
65	PL911	M. Warszawa	insignificant	insignificant
66	PL912	Warszawski wsch.	insignificant	insignificant
67	PL913	Warszawski zach.	insignificant	insignificant
68	PL921	Radomski	positive	positive
69	PL922	Ciechanowski	positive	positive
70	PL923	Płocki	insignificant	insignificant
71	PL924	Ostrołęcki	insignificant	insignificant
72	PL925	Siedlecki	insignificant	insignificant
73	PL926	Żyrardowski	negative	negative

Note: the effects in bold in column 4 present the changes after modifying the main ARDL model (1.1.) to version (2.2.) and replacing the dependent variable *GDPpc* with *GDP*.

Source: own modelling simulations.

Table A12.
Dumitrescu & Hurlin (2012) Granger non-causality test results

Lag order: 1		
W-bar =	3.8005	
Z-bar =	16.9195	(q-value = 0.0000)
Z-bar tilde =	10.0652	(q-value = 0.0000)
H0: Funds does not Granger – cause GDPpc. H1: Funds does Granger – cause GDPpc for at least one panel (ID)		

Lag order: 1		
W-bar =	1.2944	
Z-bar =	1.7778	(q-value = 0.0753)
Z-bar tilde =	0.1753	(q-value = 0.8609)
H0: GDPpc does not Granger – cause Fund. H1: GDP does Granger – cause Fund for at least one panel (ID)		

Source: the author's computation based on Statistic Poland (GUS) and Local Data Bank, Statistics Poland (GUS) datasets.