Received: 1 July 2021 | Accepted: 18 August 2021

DOI: 10.1111/jors.12566

RESEARCH ARTICLE

JOURNAL OF REGIONAL SCIENCE WILEY

One policy, different effects: Estimating the region-specific impacts of EU cohesion policy

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Funding information

Ministero dell, Università e della Ricerca to UF

Abstract

Many academic papers have looked at the economic effects of the EU cohesion policy, which still remain an open empirical issue. The focus of the most recent literature has been on the heterogeneous effects of the policy and the identification of regional conditioning factors. However, most of the existing studies generally assume slope homogeneity for different cross-sectional units (i.e., regions) and they estimate the average effects of the policy for all the European regions and/or selected groups of regions. Past works also employ data covering few programming periods. This paper has two main goals. First, we study the heterogeneous consequences of EU cohesion policy on regional economic growth in Europe over the past three decades, by applying a heterogeneous coefficient approach to new panel-time series data. We calculate the region-specific effects of the policy in terms of long-run gross domestic product growth. Second, we study regional differences in terms of policy effects depending on the level of assistance received by the regions. We make a distinction among cases of effective, ineffective, trigger and marginal policy. We also document that the effectiveness of EU cohesion policy in the long run can be explained by some of the key factors used in the literature. Finally, we discuss the need for ineffective cases to learn from effective and trigger ones.

KEYWORDS
cohesion policy, dynamic mean group estimator, EU structural funds, heterogeneous coefficient model, long-run policy effects, regional growth, regional policy

1 | INTRODUCTION

There is a long-standing, open debate about the effects of the European Union (EU) cohesion policy on promoting regional economic and social development in Europe (Dall'Erba & Fang, 2017; Ehrlich & Overman, 2020). The initial literature was divisive over the impact of cohesion funds for solving economic disparities in the European regions (Boldrin & Canova, 2001; Midelfart-Knarvik & Overman, 2002). Recent works are more optimistic (Pinho et al., 2015), by pointing out the presence of positive, even if heterogeneous effects of EU cohesion policy across Europe (Cerqua & Pellegrini, 2018; Crescenzi & Giua, 2016). This is consistent with the idea of different convergence patterns among the European countries and regions (Camagni et al., 2020; Garcilazo & Oliveira Martins, 2015), and with the uneven spatial distribution of specific conditioning factors that can improve the effectiveness of cohesion policy (Brandsma et al., 2015). Most of the existing studies, however, share the limit of using short time series often referring to a single programming period of 7 years for studying a three-decade policy (Dicharry et al., 2019). The recent availability of time series data on the EU payments, which we use in this paper, allows for the analysis of the effects of the EU funds over different programming periods, by providing adequate time coverage for most of the European regions.

One of the main issues in this field of study relates to the 'one size fits all approach' of the EU cohesion policy and the need of reconsidering national and regional differences more in depth (Bachtrögler et al., 2020; Crescenzi et al., 2020). This is particularly important today, given the uneven effects of the pandemic crisis across Europe (Ascani et al., 2021; Conte et al., 2020), and the role of cohesion policy in the Next Generation EU plan (Crescenzi et al., 2021). Although a growing number of empirical works have progressively studied the heterogeneous impact of cohesion policy on regional economies (Becker et al., 2013, 2018; Bourdin, 2019; Cerqua & Pellegrini, 2020; Le Gallo et al., 2011), there is a need of further evidence in this direction. Indeed, many studies primarily focus on specific regions like convergence ones (Becker et al., 2018; Cerqua & Pellegrini, 2020), and/or they cover few programming periods and selected countries only (Bourdin, 2019; Le Gallo et al., 2011).

In this paper, we apply panel-time series techniques to novel data on the EU expenditures covering almost four programming periods and 250 NUTS-2 regions to throw new light on the study of regional heterogeneity of cohesion funds. Our empirical analysis is conducted as follows. In the first step, we estimate the region-specific consequences of the EU funds on regional economic growth, by adopting the Dynamic Mean Group (DMG) modelling framework (Pesaran & Smith, 1995). This model has the merit of removing the hypothesis of homogeneous slope coefficients across regional units, that is, we obtain estimates for each region individually. Moreover, the DMG approach allows for the separation of the long-run effects of cohesion policy on regional growth, which are described in the cointegrating relationship, from the short-run effects of the policy (Pedroni, 2019; Pesaran et al., 1999).[1] Differently from the recent work of Fidrmuc et al. (2019), we are explicitly interested in investigating how and to what extent cohesion policy plays a heterogeneous role for regional economic growth in the long run.

In the second step of the analysis, we provide a novel investigation of the factors that can contribute to explaining the heterogeneity of the effects of cohesion policy on regional growth over the past three decades. We initially identify the regions where the policy has been effective (ineffective), by proposing a new conceptual

[1]In a companion work, we explicitly analyse the short-run effects of the cohesion policy on regional labour market resilience in the EU by adopting the DMG approach (Di Caro & Fratesi, 2021).

categorisation based on five categories—effective, ineffective, trigger, marginal and displacement policy—and using graphical mapping tools. Then, we check whether the regional differences we detect can be explained by looking at the main conditioning factors that have been used in the existing literature. We run different Logit specifications to accomplish this objective. Other things being equal, we confirm that specific conditions, such as the national context, the quality of regional institutions and the level of assistance, are key factors to understand the positive role of cohesion policy in the EU regions over the past three decades. Our results remain valid after conducting different sensitivity checks.

The rest of the paper is organised as follows. In Section 2, we provide a concise review of the literature. In Section 3, we describe the data and provide preliminary evidence. In Section 4, we present the heterogeneous coefficient modelling approach. The discussion of the results is given in Section 5, which also contains the regional classification. Section 6 discusses the factors that can help explaining the different effects of cohesion policy. Section 7 provides some sensitivity checks. Section 8 concludes with suggestions on how to use the results in policymaking. In the appendix, we include information on the data and additional calculations.

2 | LITERATURE REVIEW

The empirical literature on the EU cohesion policy can be divided into two main areas: econometric (panel and cross section) analyses and policy evaluation studies (Pieńkowski & Berkowitz, 2015). Cross-section and panel techniques are commonly applied to regional growth regressions, often augmented with spatial interaction effects (Dall'Erba & Le Gallo, 2008; Fiaschi et al., 2018), as discussed in Pinho et al. (2015). We discuss some of the limits of panel models in Section 7 of this study. Policy evaluation models, such as regression discontinuity design and synthetic control methods, are finalised to identify the causal impact of EU funds on regional economies (Becker et al., 2010; Di Cataldo, 2017; Pellegrini et al., 2013), also with the introduction of spatial interactions among neighbouring areas (Crescenzi & Giua, 2020; Giua, 2017).[2]

On the basis of the existing literature, the effects of cohesion policy on regional economies can vary depending on the following factors: industrial (Cappelen et al., 2003; Percoco, 2017) and settlement (Gagliardi & Percoco, 2017) structures; territorial capital (Fratesi & Perucca, 2014, 2019); human capital (Becker et al., 2013); institutions and governance (Di Caro et al., 2020; Rodríguez-Pose and Garcilazo, 2015); and also economic openness (Ederveen et al., 2006). The role of the EU funds can also be influenced by the different types of EU expenditures considered (Di Cataldo & Monastiriotis, 2020; Rodriguez-Pose & Fratesi, 2004).

In this study, we provide a novel categorisation of the heterogeneous effects of cohesion policy across Europe depending on the level of assistance (i.e., the amount of structural funds received by each region). We also look at the factors commonly used in the literature that can be useful to explain the region-specific effects of cohesion policy over the past three decades.

We use a novel panel-time series approach that helps us to contribute to the literature in two main directions. First, our analysis covers three decades and almost four programming periods, by allowing for the separation of long- and short-run policy effects. The consideration of different programming periods, moreover, is useful to rule out the possible influence of different definitions of assisted regions over the years (i.e., Objective 1, transition), and of the cyclical patterns of the EU expenditures in particular years (Fidrmuc et al., 2019). Second, we explicitly model the heterogeneous effects of cohesion policy on regional growth, by adding to the few works that look at heterogeneity with the application of homogeneous coefficient models (Fiaschi et al., 2018). That is, our analysis moves from the focus on average policy effects towards the explicit investigation of region-specific results.

[2]For a critical survey of policy evaluation models, see Bondonio (2019).

3 | DATA AND PRELIMINARY EVIDENCE

3.1 | Panel-time series data

We use novel data on historic EU cohesion payments provided by the EU Commission—DG regional policy that covers the years from the introduction of cohesion policy (1989) until the last available data in the data set (2015), that is, almost four programming periods (European Commission, 2017).[3] This data set contains 'regionalised' NUTS-2 annual EU expenditure data in current prices[4] for the following EU funds: European Regional Development Fund (ERDF), Cohesion Fund, EAFRD/EAGGF and ESF. The regionalisation of payments is based on the NUTS-2013 version, and it is not possible to distinguish between national and regional funding programmes. More details on the construction of the data and the regionalisation procedure are provided in WIIW Study (2016). We use modelled regionalised annual EU payments that represent the actual annual expenditure data registered at a regional level: they do not necessarily follow the yearly cycle of the EU payments, but they replicate the timing of 'real expenditures taking place on the ground' (European Commission, 2017). This choice is motivated by the fact that modelled data do not contain gaps in the series; this is particularly relevant at the end of each programming period to avoid cyclical patterns (Fidrmuc et al., 2019).

We focus on ERDF data for the following reasons. First, ERDF data show the longest time coverage in the sample. Second, ERDF expenditures are explicitly finalised to sustain regional economic growth and development, which is not necessarily the case with other policies financed through different funds (Fratesi, 2016). Third, the ERDF is the most relevant EU cohesion policy fund in terms of allocated resources: more than 50% over the programming period 2014–2020. Moreover, we focus on NUTS-2 regions because of data availability and, more compellingly, since regions are the relevant targeted areas of EU cohesion policy. Data on the EU expenditures are available from around 1990 onwards for the EU-15 regions in the old member states (MS), and from around 2000 onwards for 10 new MS (NMS). We exclude from our analysis regions in Bulgaria, Croatia and Romania for which data are not available for a sufficient number of years (Incaltarau et al., 2020). In the appendix, Table A1, we report details about the number of regions and available years in our data set.[5]

Our data set also includes information on regional GDP that we use to construct our dependent variable. We have data on regional population, gross value added divided by productive sectors (e.g., agriculture, manufacturing, etc.) and employment; data from Cambridge Econometrics. We also collect data before the EU cohesion policy period to have some knowledge of the prepolicy economic trends observed in the different European regions. In the appendix, Table A2, we provide summary statistics for the main variables used in the first step of this study.

In Figure 1, we report the variable describing the EU cohesion payments over time in two selected EU countries, Italy and Poland, which are among the top recipients of EU cohesion policy expenditures in the sample. In Italy, where cohesion policy has been operative since the early 1990s, we can observe regional heterogeneity patterns within the country, which reflects the structural North–South divide. Interestingly, in Poland, where cohesion policy has been mostly operative from the 2000s onwards, a certain degree of internal heterogeneity is also observable, though this country as a whole currently receives a large share of the EU cohesion policy funds. Therefore, it can be interesting to look at local, region-specific policy results in the different European regions, both in the old and new MS, to throw further light on the effects of cohesion policy (Le Gallo et al., 2011).

[3]In the case of EU-funded programmes covering more than one NUTS-2 region, the regionalisation of the payments was carried out by the EU Commission using regionalised data provided by the managing authorities and/or applying specific apportioning rules to the payments. This version of the paper uses the data release of April 1, 2019, available at https://cohesiondata.ec.europa.eu/Other/Historic-EU-payments-regionalised-and-modelled/tc55-7ysv.

[4]To check for possible regional price effects, we use EU expenditure data in real values adjusted for regional gross domestic product (GDP) deflators as an alternative variable. Results, available upon request, are not significantly different from the usage of nominal values.

[5]We also exclude some regions in France (e.g., DOM and TOM) and in the United Kingdom (e.g., London region) for which information on the EU funds is not available in the data set.

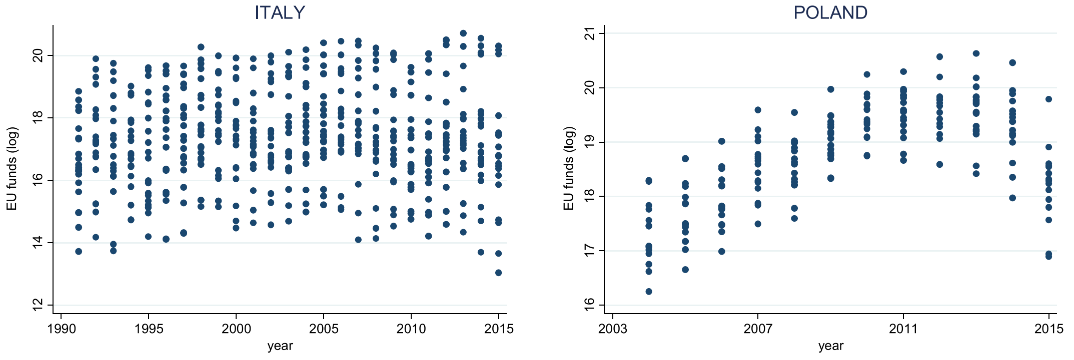

FIGURE 1 EU cohesion payments in Italy and Poland. *Note*: Our elaborations, EU payments data

3.2 | Stationarity and cointegration in the series

Our interest in the estimation of the long-run relationship between our dependent variable, regional GDP (in log) and the variable describing the EU cohesion payments (in log) is supported by the results of preliminary panel tests on stationarity and cointegration. Tests results are reported in the appendix (Table A3) to save space. We find evidence of panel nonstationarity for our dependent variable and the main covariate of interest for the regions in the old and new MS, as well. The presence of panel unit root is confirmed after applying different tests—Im–Pesaran–Shin test, Fisher ADF test, Philips–Perron test and Hadri LM test—that allow for the specification of different alternative hypotheses (Breitung & Pesaran, 2008). Our stationarity test results are robust to different lag length selection, the introduction of time trend and the consideration of cross-sectional averages across panel units. More details on testing hypotheses and results are provided in Table A3.

We preliminary test for the presence of panel cointegration between regional GDP and the EU cohesion policy variable (in levels) to verify if the $I(1)$ series are in a long-run equilibrium. The presence of cointegration (of order one) between the two variables, at least for some panels in our data set, is detected after applying different panel cointegration tests—Kao test, Pedroni test and Westerlund test—that allow for the consideration of different alternative hypotheses (Westerlund, 2007). Test results are reported in Table A3. Note that, consistent and efficient estimates of the parameters in the long-run relationship between integrated variables can be obtained by adopting the autoregressive distributed lag (ARDL) approach (Pesaran & Shin, 1995). This approach, which we follow in this paper, is also indicated for estimating coefficient heterogeneity among panel units to obtain super-consistent estimates of the long-run equilibrium relationship (Pesaran & Smith, 1995). The presence of cointegration, moreover, represents a form of robustness to different empirical problems, including the violation of the exogeneity condition for the regressors, when the reasons for such violation are not extreme (Pedroni, 2019). In Section 7, we further discuss possible endogeneity concerns in our analysis.

4 | METHODOLOGY

In the first step, we estimate the region-specific effects of the EU cohesion policy on regional economic performance, by allowing for heterogeneous coefficients in the long-run equilibrium relation. Our starting point is the following general ARDL (p, q) model (Pesaran et al., 1999):

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij}\, y_{it-j} + \sum_{j=0}^{q} \boldsymbol{\beta}'_{ij} EUpolicy_{i,t-j} + \sum_{j=0}^{q} \boldsymbol{\pi}'_{ij} \boldsymbol{x}_{i,t-j} + \varepsilon_{it}, \quad (1)$$

where the dependent variable is the (log of) regional GDP in region i ($i = 1, \ldots, I$, with $I = 250$) at time t ($t = 1990, \ldots, 2015$). Data for the years 1990–2015 are used for the EU-15 regions, while data for the years 2000–2015 are used for the EU-10 regions. The main covariate of interest is the explanatory variable $EUpolicy_{it-j}$ that describes the (log of) ERDF cohesion payments per capita on a regional level; we add 1 before taking logs since some regions receive no cohesion funds in some years. Moreover, $\mathbf{x}_{i,t-j}$ is a vector of controls: In our baseline estimates, we always include the (log of) regional population as a standard control in dynamic regional growth models (Chodorow-Reich et al., 2012). The term ε_{it} is the error component: In our baseline estimates, we add cross-sectional means to take into account observed (spatial) common-factors among the regional units. Finally, time-specific effects can be added to (1) for taking into consideration common time effects (Hsiao, 2014).

The dynamic specification of the model in (1) needs to be sufficiently augmented so that the regressors are strictly exogenous and the residual of the resulting error-correction model is exogenous and serially uncorrelated (Pesaran & Shin, 1995). However, with a moderate number of time series observations as in our case, the ARDL order cannot be overextended as this imposes excessive parameter requirements on the data. In our case, we select an ARDL (1, 1) model on the basis of common selection criteria (i.e., Schwartz–Bayesian Criterion). As we discuss in Section 7, our estimates of the long-run coefficients are robust to the order of the ARDL model in (1) (Pesaran et al., 1999). Note that, the introduction of cohesion policy variable with a lag of 1 year is motivated by noting that projects financed by the cohesion funds become effective for regional economies after some time lag (Mohl & Hagen, 2010).

On the basis of panel stationarity and cointegration test results, as discussed in Section 3, we rewrite the relation in (1) in the following simplified error-correction form, after limiting the observation to the main covariate of interest:

$$\Delta y_{it} = \phi_i(y_{it-1} - \beta_{1i} EUpolicy_{it-1}) + \beta_{2i} \Delta EUpolicy_{it-1} + \varepsilon_{it}, \tag{2}$$

where $\phi_i = -(1 - \lambda_i)$ is the speed of error-correction adjustment.[6] Note that, in the relation (2), all the coefficients (and the variances) can differ across the different regions (Pesaran & Smith, 1995). The model in (2) is the (dynamic) mean group model, where no particular restrictions on the homogeneity of the coefficients among the units are imposed. The DMG model is estimated separately for each unit and then the resulting coefficients are averaged across units. The preference for the DMG model, which considers both short- and long-run heterogeneity coefficients, is supported by Hausman-type tests, where the DMG model is compared with alternative models, like, the pooled mean group and the dynamic fixed effects (Ditzen, 2018).

5 | DISCUSSION OF THE RESULTS AND REGIONAL POLICY CATEGORIES

5.1 | Region-specific outcomes

Since we are interested in the coefficients that capture the heterogeneous long-run elasticity of the EU cohesion policy on regional GDP, we discuss here the region-specific results obtained from the estimates of the coefficient β_{1i} in the relation (2). For each region in our sample, the region-specific coefficients describe the percentage variation of regional GDP following a 1% change in the (log of) EU cohesion funds. On average, we find that a 1% increase of EU cohesion policy expenditure produces a positive, significant variation of regional GDP of about 0.07% in the EU-15 regions. Our aggregate results are in line with the findings of the contributions reviewed in Dall'Erba and Fang (2017) and, more compellingly, with recent evidence in Fidrmuc et al. (2019) who employ a similar data set for an aggregate analysis. As for the EU-10 regions

[6]The parameter ϕ_i must be different from zero to have a significant long-run relationship. This parameter is expected to be significantly negative under the prior assumption that the variables show a return to a long-run equilibrium. In our baseline specifications, the (average) speed of adjustment is equal to −0.1477 (0.000) and −0.2301 (0.000) for the EU-15 and EU-10 regions, respectively; p values are in parentheses.

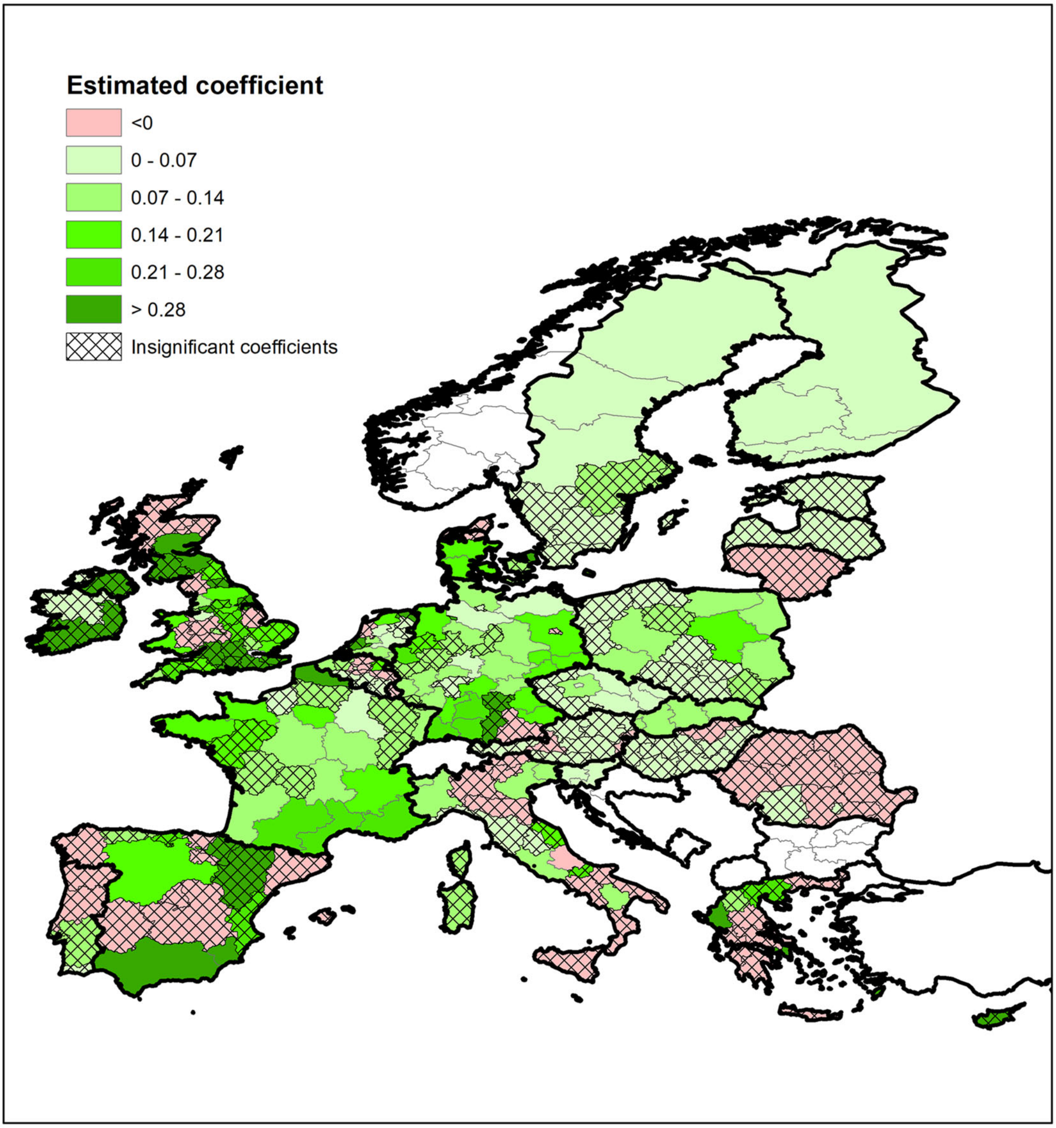

FIGURE 2 Region-specific effects of cohesion policy on regional growth. *Note*: Our elaborations from first-step estimation results

in the NMS, we find that a 1% increase of EU cohesion policy produces a positive, significant variation of regional GDP of about 0.05%, in line with existing evidence (Crescenzi et al., 2017).

To illustrate the new evidence on region-specific results, in Figure 2, we map the β_1 coefficients for the European regions obtained from the estimation of model (2) for the regions in the EU-15 and EU-10 MS, separately. Shaded areas describe the regions where the estimated beta coefficients are not statistically significant at 5% level. From our calculations, it follows that the long-run impact of ERDF on regional growth is far from homogeneous across Europe. Such heterogeneity, moreover, is detected across and within the

European countries, and both in the old and new MS.[7] In particular, positive and significant effects are observed in most of the EU countries, including some MS that received a relatively low amount of funds (e.g., Finland and Sweden). Conversely, there are countries, such as Hungary, where the economic effects of cohesion policy are still under evaluation (Loewen, 2018), which register insignificant effects of cohesion policy on regional economic growth.

Interestingly, in the old MS, there are several regions that do not show positive, significant long-run effects of cohesion policy, including most of Italian Objective 1 regions located in the South, and some regions in Portugal and Greece. As for Greece, a positive, significant impact is detected in Athens and Ipeiros; in Spain, a positive effect is detected in Murcia and Andalucía. Our findings can be interpreted as complimentary to the results presented in previous works like Fiaschi et al. (2018) where a mapping of cohesion policy effects is provided for the old MS. Specifically, our analysis covers more regions and over a longer time period than previous contributions. However, in contrast to Fiaschi et al. (2018) where the indirect (spatial) effects of cohesion policy are also considered, our results look at the direct, region-specific consequences of the policy only.

5.2 | Regional classification: Levels of assistance and policy effects

On the basis of previous results, we now provide a novel classification of the EU regions depending on the effects of the policy and the level of assistance received. That is, we investigate whether the different impact and significance of the EU cohesion policy on regional growth, as detected in the first step of our analysis, can be associated with the heterogeneous amount of EU funds that the regions have received over the different programming periods. We start by defining five categories of regions that are conceptually possible, as reported in Table 1. The impact of the policy refers to the region-specific long-run coefficients that we have estimated in the first step of our analysis. The level of assistance is defined by comparing the ERDF funds per capita allocated to a given region over the observation period with respect to the average ERDF funds per capita registered in the relative group of regions (i.e., EU-15 and EU-10).

In Figure 3, we map the resulting regional categories. Regions in green are those for which we find a positive, significant estimated beta coefficient (i.e., effectiveness of the policy), while regions in red are those for which we do not find statistically significant beta coefficients. Moreover, the degree of colour intensity describes the level of assistance, with dark colours that denote the regions that registered a level of assistance higher than the group average, and light colours the regions where the level of assistance is lower than the group average. Some comments are worth observing. The regions that show a level of assistance higher than the EU average allocation are the poorer and the peripheral ones in Europe. Interestingly, in this category, there are many regions that show positive long-run effects of cohesion policy on regional economic growth. However, there are also several highly assisted regions for which we do not find a significant impact of cohesion policy. In Section 6, we discuss some of the possible factors that can help explaining such regional differences across Europe.

We find that for a large number of regions in Portugal, Spain, Greece, and in the Italian *Mezzogiorno* the policy has been *ineffective* in the long run, though the high levels of funding from the EU. This result is in line with the view that there are persistent difficulties in these countries, including the progressive reduction of cofinancing rates and national ordinary resources, for an effective implementation of the policy (Aiello & Pupo, 2012).

[7]We find that only one region, Abruzzo in Italy, shows a negative and significant effect of the cohesion policy on regional GDP growth over the sample period. This result can be explained, among other factors, by the fact that in 2009, in this region there was an earthquake that produced long-lasting effects (Modica et al., 2019). Indeed, if we restrict our sample before 2009, the negative coefficient of the cohesion policy on regional growth in Abruzzo disappears. Abruzzo, moreover, was the first Italian region to exit from the Objective 1 support mechanism, without receiving transition funds, with possible long-term effects (Barone et al., 2016).

TABLE 1 Regional classification of cohesion policy effects and level of assistance

	Level of assistance	
	High level of assistance	Low level of assistance
Policy impact		
Positive impact	Case 1 Effective policy	Case 2 Trigger policy
Negligible impact	Case 3 Ineffective policy	Case 4 Marginal policy
Negative impact	Case 5 Displacement policy[a]	

Note: Policy impact is defined, as explained in the main text, from the results of the region-specific estimates of the relation (2): positive and significant coefficients (positive impact), positive and not significant coefficients at 5% level of statistical significance (negligible impact), negative and significant coefficients (negative impact). The level of assistance is defined in the main text with respect to the allocated EU funds relative to the group of reference of each region (EU-15 and EU-10).
[a]Case 5 is observed for the Italian region Abruzzo only; see footnote 6 for an explanation.

In other cases, however, the policy has been *effective* as desirable, especially in regions belonging to Eastern Germany, Northern Scandinavia, Eastern Poland, Slovakia, the Czech Republic, as well as in Nord-Pas de Calais, West Wales, Cornwall, Basilicata and Castilla-i-Leon.

Moreover, we detect a nonnegligible number of *trigger* regions, where positive, significant effects are registered even in the presence of relatively low amounts of EU funding. This category includes some regions located in France, the western part of Germany, the Netherlands, Finland and Denmark. The presence of trigger regions is consistent with the idea that different regions can register different policy-supported growth paths (Isaksen & Trippl, 2017).

Finally, yet importantly, we find that there are regions (e.g., in southern Britain, Belgium, Centre-North of Italy, etc.) where the policy has been *marginal*, that is, we do not find significant effects on regional growth from a statistical point of view in a situation of low assistance.

6 | ANALYSING REGIONAL DIFFERENCES IN COHESION POLICY EFFECTS

To complete the understanding of regional differences in cohesion policy effects, in this section, we investigate the presence of some explanatory factors that can be related to the asymmetric distribution of the effectiveness of cohesion policy in the long run presented in Section 5.

In detail, we start from the following cross-section Logit model representation:

$$policy\text{-}effect_i = \alpha_i + \sum_{j=1}^{J} \delta_j nat\_fact_{ij} + \sum_{k=1}^{K} \gamma_k reg\_fact_{ik} + \delta fund_i + \varepsilon_i, \quad (3)$$

where the binary dependent variable $policy \quad effect_i$ (with i representing the region) takes the value of zero for the regions for which we do not detect significant β_1 coefficient estimates in the estimation of the relation (2) and the value of one for the regions for which we find positive, significant β_1 coefficient results.

The choice of the Logit representation is justified by two main reasons. From our first-step DMG model estimates, we end up with about 100 out of 250 positive, significant regional coefficients for the policy variable describing cohesion policy. For the remaining regions, we do not detect significant policy effects at least at 5%

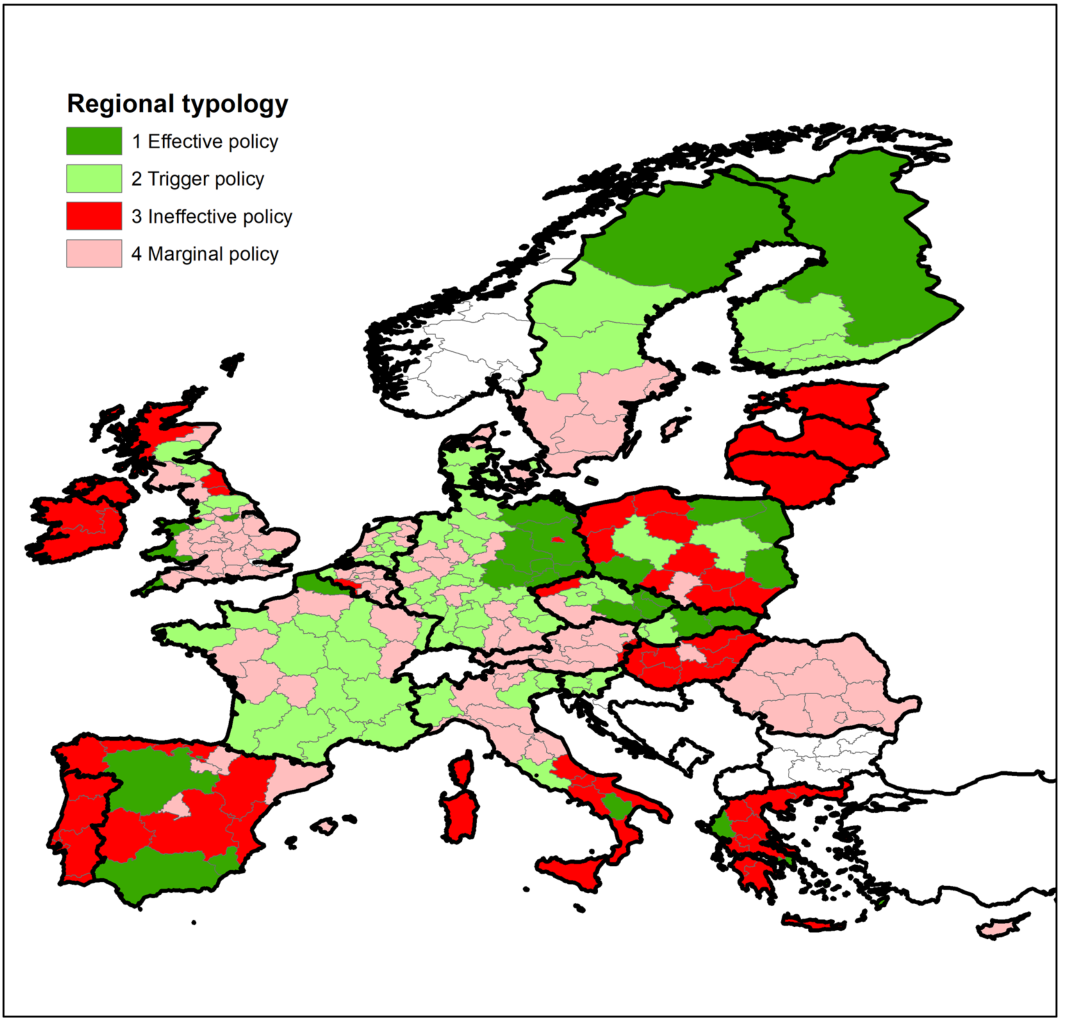

FIGURE 3 Mapping the policy impact and the level of assistance in the EU regions. *Note*: Our elaborations from first-step estimation results and Table 1 categories

levels of statistical significance. Therefore, we prefer to use the Logit approach that allows for the modelling of a truncated dependent variable with many zeros. We are interested in exploring the reasons that can help understand the presence of cohesion policy effectiveness, which is measured by positive long-run beta coefficients obtained from the first step of our analysis.

In the baseline results reported in this section, the set of explanatory variables nat_fact_j is made up of different national context variables based on the existing cohesion policy studies. Specifically, we consider the national level of GDP per capita as a proxy of country economic development. We also include a dummy variable for the old MS that allows for the consideration of possible different convergence patterns across regions; a dummy variable for the Euro area regions that can be considered as an indicator of macroeconomic stability, at least in terms of monetary policy.

The set of regional factors reg_fact_k includes: a variable describing the level of regional institutions and quality of government measured by the EU Quality of government data (Charron et al., 2014, 2019); a covariate for regional human capital from the EU Regional Competitiveness Index; and a dummy variable for the presence of agglomeration economies calculated from the definition of agglomerated areas in the ESPON classification (Capello et al., 2015).

The covariate $fund_i$ captures the level of EU cohesion expenditures in a given region, calculated as the average real expenditure per capita registered over the observation period. In the appendix, we report details on the variables used in the Logit regressions (Table A4), and correlation coefficients (Table A5).

Table 2 shows the Logit estimation results with robust standard errors and errors clustered at the country level to consider possible, unobserved national confounding factors. Our results mostly confirm the findings of previous contributions looking at the conditionalities that can explain the effectiveness of regional cohesion policy. The likelihood of having positive, significant cohesion policy consequences on regional economies is registered in more developed MS, with higher GDP. Being in the Euro area also seems to be positively associated with the likelihood to get a positive impact of the policy, possibly suggesting the positive role of monetary and price stability.

As for the regional factors, we find that high quality of regional institutions and government increases the effectiveness of cohesion policy (Rodriguez-Pose & Di Cataldo, 2015; Rodríguez-Pose & Garcilazo, 2015). We do not find evidence on the role of agglomeration economies for explaining cohesion policy effectiveness. This is probably due to the fact that we focus on NUTS-2 regions, which represent areas that are too large to identify agglomeration economies. Indeed, cohesion policies studies that find positive effects of agglomerations use finer observation units at NUTS-3 level (Gagliardi & Percoco, 2017). We also find that human capital plays a positive role for explaining cohesion policy effectiveness, once decreasing returns (i.e., squared variable) are taken into consideration (Becker et al., 2013; Rodriguez-Pose & Fratesi, 2004). Finally, yet importantly, we confirm the view that the level of EU cohesion expenditures matters for understanding the region-specific consequences of the policy, though with decreasing returns and mild effects (Becker et al., 2012; Cerqua & Pellegrini, 2018).

7 | SENSITIVITY ANALYSIS

In this section, we check for the robustness of our results to alternative specifications of the first- and second-step estimates. As for the first-step analysis, we have estimated the long-run relation between regional GDP and the EU cohesion policy, by applying the following modifications; the results for the main variables of interest are reported in the appendix (Table B1). For the EU-15 regions, we have estimated the relation in (2) from 2000 onwards to be coherent with the estimates obtained for the EU-10 regions (col. MG1). We have also augmented the lag order of the ARDL specification, with the inclusion of two lags for both GDP and cohesion policy variable to control for possible effects of serial correlation (cols. MG2 and MG5). Moreover, we have used data on regional GDP per capita as alternative dependent variable (cols. MG3 and MG6). As for the EU-10 regions, we have checked our results for the exclusion of small countries—the three Baltic Republics, Cyprus and Malta—from the sample of NMS (col. MG4). The main findings of our work are not modified after these changes.

In the first-step analysis, the variable describing cohesion policy can be affected by endogeneity when using panel data approaches (Giua, 2017): Some unobserved variables, such as institutional quality, can simultaneously influence EU payments and the dependent variable. In our case, reverse causality problems are likely to be reduced given that we use panel-time series data and the lag of cohesion policy variable, in line with the existing literature (Pinho et al., 2015). We do not find instances of endogeneity for the lagged covariate *EUpolicy* in the relation (2) after adopting the modified Hausman test. Moreover, it is important to observe that in our ARDL model the presence of cointegration between our dependent variable and the policy variable limits the relevance of endogeneity issues in the specification (Pedroni, 2019). However, for the sake of completeness, we have estimated the long-run relationship by adopting a dynamic panel GMM model (Roodman, 2009). The results are reported in Table B1 for the EU-15 (GMM1) and EU-10 (GMM2) regions, respectively; further details on the GMM estimates are reported at the bottom of the table.

TABLE 2 Logit regressions results

Dependent variable: *Policy effect* (1 = positive, significant beta coefficients from the first step; 0 otherwise)					
Explanatory variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Country GDP per capita	0.505**	0.599***	0.558***	0.592***	0.584***
	[0.214]	[0.198]	[0.189]	[0.196]	[0.199]
EU-15 (dummy)	−1.674*	−3.023***	−2.966***	−3.101***	−2.882***
	[0.885]	[0.936]	[0.926]	[0.957]	[0.969]
Euro (dummy)	0.875#	1.289***	1.272**	1.282**	1.290**
	[0.556]	[0.498]	[0.498]	[0.507]	[0.509]
EQI index		0.711***	0.635***	0.720***	0.845***
		[0.236]	[0.230]	[0.276]	[0.321]
Metropolitan regions (dummy)		−0.292	−0.324	−0.280	−0.282
		[0.365]	[0.356]	[0.359]	[0.347]
Human capital		0.016	0.172*	0.173*	0.133#
		[0.028]	[0.097]	[0.098]	[0.098]
Human capital (RCI) squared			−0.003*	−0.003*	−0.002#
			[0.002]	[0.002]	[0.002]
ERDF expenditure per capita				0.000	0.000#
				[0.000]	[0.000]
ERDF expenditure per capita squared					−0.000#
					[0.000]
Constant	−2.847**	−2.966**	−4.452**	−4.759***	−4.671***
	[1.192]	[1.368]	[1.757]	[1.797]	[1.743]
Observations	243	243	243	243	243
$r2_p$	0.0486	0.0904	0.0963	0.0984	0.105
χ^2	5.769	23.38	33.65	34.86	n.c.
p	0.123	0.000680	2.00e−05	2.83e−05	n.c.

Note: Robust standard errors in parentheses.

Abbreviations: EQI, Environmental Quality Index; ERDF, European Regional Development Fund; GDP, gross domestic product; RCI, Regional Competitiveness Initiative.

*$p < 0.10$.

**$p < 0.05$.

***$p < 0.01$.

#$p < 0.20$.

As for the Logit regressions, we have included different national and regional explanatory factors in the relation (3), as reported in Table B2. The main additional covariates include alternative variables, for which we have sufficient time and regional information, such as a different description of agglomeration economies (i.e., population density and population density squared), and the level of EU expenditures in the NMS. The main messages of our analysis remain unchanged after the introduction of additional explanatory variables.

8 | CONCLUDING REMARKS

In this study, we have provided new evidence on the region-specific consequences of the EU cohesion policy on the long-run regional GDP growth of European regions, thanks to the new availability of panel-time series data for the EU cohesion policy expenditures covering a period of about three decades and a technique hitherto never applied to this topic.

The application of a heterogeneous coefficient model has been useful to show the different degrees of heterogeneity in cohesion policy effectiveness across Europe, and separate the short- and the long-run effects of the policy. On the basis of the empirical results, three main messages derive from our analysis.

First, the long-term macroeconomic effect of the EU policy varies across and within EU countries, with positive and significant effects registered in about 40% of EU regions in our sample. This suggests that regional specificities need to be considered when discussing about the one size fits all approach of regional policy in Europe (Bachtler et al., 2019).

Second, we have documented that the degree of effectiveness of cohesion policy does not necessarily depend on the level of assistance received by the regions over the past. Indeed, from our new regional classification, we show that there are regions where large amounts of cohesion funds do not correspond to positive growth effects, which we label as cases of ineffective policy. This category includes several regional areas in Southern and Mediterranean MS. Conversely, there are regions, mostly located in Germany and France, which received relatively low amount of EU funding, but where we find positive and significant policy effects (cases of trigger policy). There are also cases of effective policy, with high amount of funds and positive and significant effects, like in Eastern Germany, in some NMS and Northern countries.

Finally yet importantly, our results suggest that the heterogeneous effects of cohesion policy effectiveness can be related to the presence of a selected number of national and regional contextual factors, including the level of national development, the quality of regional institutions and regional human capital endowment.

Although our aggregate results are in line with previous cohesion policy studies, the quantitative analysis throws new light into this field of study, by exploiting all informative power of new, long series data. From a policy perspective, our analysis confirms that national and regional features have to be adequately considered when comparing the long-run performance of the EU cohesion funds (Crescenzi & Rodríguez-Pose, 2012).

While the results on the conditioning factors which are detected in this paper are, on average, consistent with those already existing in the literature, the classification of the individual regions is a new result which could have relevant policy applications.

In particular, regions where policy has been effective should be studied in detail and, even more, studies are needed on regions where the policy had trigger effects, to understand more specifically what conditions and specific policy programmes brought these positive results, to extend them to the other regions.

Regions where the policy has been ineffective, on the contrary, should be the main target of cohesion policy in the future. Since in terms of funding these regions have already been receiving a significant amount of money, the adjustment of interventions should mostly be in terms of governance, to make their use of EU funding more similar to the one of trigger and effective regions.

Given the relevance of cohesion funds also in the Next Generation EU package, understanding the reasons that hamper the effectiveness of cohesion policy in specific regions is crucial in achieving the future goals of cohesion policy strategies.

ACKNOWLEDGEMENTS

We wish to thank Marco Percoco, John Walsh and the participants at different conferences and seminars where preliminary versions of the work were presented (this includes RSA Winter Conference 2018 in London, ICUBERD 2018 in Pecs, ERSA Congress 2019 in Lyon, Annual Conference of the Italian Economic Association (SIE) 2019 in Palermo) for helpful discussions and comments. The views expressed in the paper do not reflect those of the institutions of affiliation. Ugo Fratesi acknowledges partial funding from PRIN project "A new assessment of cohesion policies' effectiveness: Macro and micro approaches." The usual disclaimer applies.

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How to cite this article: Di Caro P., & Fratesi, U. (2022). One policy, different effects: Estimating the region-specific impacts of EU cohesion policy. *Journal of Regional Science*, 62, 307–330.
https://doi.org/10.1111/jors.12566

APPENDIX A

A.1 | Data description, summary statistics and tests

TABLE A1 Data description of historic EU cohesion (modelled) payments

Country	NUTS-2 regions	Sample period[a]
Austria	9	1994–2015
Belgium	11	1990–2015
Bulgaria[b]	6	2007–2015
Cyprus	1	2001–2015
Croatia[b]	2	2007–2015
The Czech Republic	8	2001–2015
Denmark	5	1990–2015
Estonia	1	2002–2015
Finland	5	1994–2015
France	18	1989–2015
Germany	39	1990–2015
Greece	13	1987–2015
Hungary	7	2002–2015
Ireland	2	1989–2015
Italy	21	1988–2015
Latvia	1	2001–2015
Lithuania	1	2001–2015
Luxemburg	1	1991–2015
Malta	1	2001–2015
The Netherlands	12	1990–2015
Poland	16	2001–2015
Portugal	7	1987–2015
Romania[b]	8	2007–2015
Slovakia	4	2001–2015
Slovenia	2	2002–2015
Spain	19	1989–2015
Sweden	8	1994–2015
United Kingdom	53	1989–2015

[a]We use the first year for which information is available for all the regions in a given country.

[b]Country excluded from the analysis.

TABLE A2 Descriptive statistics, first step

Variable	Mean	Stand. Dev.	Min.	Max.
GDP growth (EU-15)				
Overall	0.0142	0.0364	−0.6055	0.3543
Between		0.0080	−0.0038	0.0536
Within		0.0355	−0.5873	0.3719
GDP growth (EU-10)				
Overall	0.0283	0.0358	−0.1603	0.1424
Between		0.0093	0.0066	0.0486
Within		0.0346	−0.1724	0.1222
(log of) EUfund (EU-15)				
Overall	16.3986	2.5398	0	21.0223
Between		1.7466	0	20.4995
Within		1.8477	0	19.5783
(log of) EUfund (EU-10)				
Overall	17.4509	3.0296	0	20.6260
Between		0.8289	0	19.0358
Within		2.9167	0	21.2474
(log of) Population (EU-15)				
Overall	7.1566	0.8967	3.2456	9.4003
Between		0.8976	3.3131	9.3382
Within		0.0461	6.7751	7.3769
(log of) Population (EU-10)				
Overall	7.3382	0.5132	5.9765	8.5892
Between		0.5184	6.0197	8.5607
Within		0.0249	7.2252	7.4332

Note: Overall refers to variations over time and units/regions; between refers to variations across units/regions; within refers to variations over time. EU-15 regions ($n = 208$, $T = 25$) and EU-10 regions ($n = 42$, $T = 15$).

Abbreviation: GDP, gross domestic product.

TABLE A3 Panel unit root and cointegration tests

Unit root test	Variable *Null hyp.: H0*	*GDP level (EU-15)*	*GDP level (EU-10)*	*(log of) EUfund (EU-15)*	*(log of) EUfund (EU-10)*
Im–Pesaran–Shin (*W-t-bar*)	*All panels have a unit root*	1.7688 (0.9615)	1.8443 (0.9674)	−29.7025* (0.0000)	−32.8820* (0.0000)
Augmented Dickey–Fuller (*inverse normal*)	*All panels have a unit root*	3.2103 (0.9993)	2.2877 (0.9889)	−45.2926* (0.0000)	−0.0109 (0.4957)
Philips–Perron (*inverse normal)*	*All panels are nonstationary*	2.9366 (0.9983)	4.1683 (1.0000)	−18.5621* (0.0000)	−42.437* (0.0000)
Hadri LM (*Z-stat*)	*All panels are stationary*	110.3741* (0.0000)	25.1597* (1.0000)	54.1982* (0.0000)	25.7385* (0.0000)
Cointegration test	***Null hyp.: H0***	***EU-15***		***EU-10***	
Kao test (*modified Dickey–Fuller t*)	No cointegration	3.0730 (0.0011)		2.8808 (0.0020)	
Pedroni test (*modified Philips–Perron t*)	No cointegration	9.9054 (0.0000)		6.2504 (0.0000)	
Westerlund test (*variance ratio*)	No cointegration	8.1134 (0.0000)		7.8226 (0.0000)	

Note In every test, the lag length has been selected according to the AIC criterion; the option demean has been used to compute the mean of the series across panels and subtracts this mean from the series. p values are in parentheses; * denotes the rejection of the null hypothesis. EU-15 regions ($n = 208$, $T = 25$) and EU-10 regions ($n = 42$, $T = 15$).

Abbreviation: GDP, gross domestic product.

TABLE A4 Data source and information, Logit analysis

Variable	Source	Year/dummy
Country GDP per capita	Cambridge Econometrics	1990–2015
EU-15 countries	Eurostat	Dummy
New EU countries	Eurostat	Dummy
EU South (ES, EE, IT, PT)	Eurostat	Dummy
Metropolitan areas	ESPON database	Dummy
Population density	Eurostat	1990
Amount of policy support	Authors' calculations starting from data of Lo Piano Chifari Saltelli Vidoni Strand (2018) and Cambridge Econometrics	1990–2005
Human capital	Population aged 25–64 with higher educational attainment (ISCED5_6);% of total population of age group From EU Regional Competitiveness Index	2007
Quality of Government	EU QoG data (Gotenburgh) (Charron et al., 2014, 2019)	2010

Abbreviation: GDP, gross domestic product.

TABLE A5 Spearman rank correlation matrix, Logit analysis

Variables	*Dep. variable*	*Nat. GDP per capita*	*EU-15 (dummy)*	*Euro (dummy)*	*EQI index*	*Human capital*	*Metrop. regions (dummy)*	*Population density*	*ERDF exp. per capita*
Dep.	1								
Nat. GDP per capita	0.1661*	1							
EU-15 (dummy)	−0.012	0.5406*	1						
Euro (dummy)	0.0956	0.1172*	0.4630*	1					
EQI index	0.1455*	0.3628*	0.4634*	−0.0072	1				
Human capital	0.0383	0.2858*	0.3291*	−0.1666*	0.4968*	1			
Metrop. regions (dummy)	0.0681	0.2708*	−0.0663	−0.1092*	0.1541*	0.2758*	1		
Population density	0.0078	0.3355*	0.1554*	0.0469	0.1346*	0.2341*	0.3895*	1	
ERDF exp. per capita	−0.0673	−0.3987*	−0.3164*	0.0061	−0.6329*	−0.3929*	−0.2893*	−0.4179*	1

Abbreviation: EQI, Environmental Quality Index; ERDF, European Regional Development Fund; GDP, gross domestic product.

*Denotes significance at 10% confidence level.

APPENDIX B

B.1 | Additional results

TABLE B1 Alternative specifications of long-run equation, EU-15 and EU-10 regions

Dependent variable	*GDP growth*							
Model	EU-15				EU-10			
Explanatory variables	(MG1)	(MG2)	(MG3)	(GMM1)	(MG4)	(MG5)	(MG6)	(GMM2)
EUpolicy	0.0661** (0.0362)	0.0654** (0.0310)	0.1179** (0.0563)	0.1383*** (0.0178)	0.0550*** (0.006)	0.1345** (0.0670)	0.0567** (0.0233)	0.0468*** (0.0042)
Speed of. adj.	−0.2237*** (0.0111)	−0.0523** (0.0255)	−0.1698*** (0.0148)	-	−0.2415*** (0.0246)	−0.0840** (0.0350)	−0.2186*** (0.0255)	–
Years from 2000/no small countr.	YES	–	–	–	YES	–	–	–
Augmented ARDL	–	YES	–	–	–	YES	–	–
GDP per capita	–	–	YES	–	–	–	YES	–
Endog. check	–	–	–	YES	–	–	–	YES
Observations	3328	5200	5200	5200	555	630	630	630

Note: The augmented ARDL specifications include two lags of GDP and the EU policy variable; the coefficient reported for the EU policy variable is the sum of the lagged coefficients; the p values of the null hypothesis of joint insignificance are equal to 0.003 and 0.000, respectively. The GMM estimates for the EU-15 regions produce: F-stat = 60.20 (0.000); AR(1)-test (0.100); AR(2)-test (0.100); Difference in Hansen Test (0.410). The GMM estimates for the EU-10 regions produce: F-stat = 124.52 (0.000); AR(1)-test (0.114); AR(2)-test (0.114); Difference in Hansen Test (0.702). p values in parentheses. Lag order GMM (2 3); option collapse used for reducing the number of instruments (Roodman, 2009).

Abbreviations: ARDL, autoregressive distributed lag; GDP, gross domestic product; GMM, generalized method of moments.

**$p < 0.05$.

***$p < 0.01$.

TABLE B2 Additional estimates, Logit analysis

Dependent variable: *Policy effect* (1 = positive, significant beta coefficients from the first step; 0 otherwise)											
Exp. variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
Country GDP per capita	0.559***	0.559***	0.600***	0.588***	0.609***	0.594***	0.599***	0.588***	0.609***	0.599***	0.588***
	[0.192]	[0.199]	[0.205]	[0.209]	[0.198]	[0.201]	[0.205]	[0.209]	[0.199]	[0.205]	[0.209]
EU-15 (dummy)	−2.842***	−2.860***	−3.031***	−2.817***	−3.038***	−2.799***	−2.735#	−2.824#	−2.681#	−2.735#	−.824#
	[0.892]	[0.937]	[0.966]	[1.004]	[0.902]	[0.934]	[2.056]	[2.050]	[1.883]	[2.056]	[2.050]
Euro (dummy)	1.241**	1.203**	1.215**	1.220**	1.262**	1.264**	1.229**	1.220**	1.279**	1.229**	1.220**
	[0.495]	[0.476]	[0.483]	[0.485]	[0.506]	[0.510]	[0.478]	[0.485]	[0.505]	[0.478]	[0.485]
EQI index	0.707***	0.656**	0.757**	0.875***	0.802***	0.956***	0.756**	0.875***	0.802***	0.756**	0.875***
	[0.237]	[0.262]	[0.303]	[0.333]	[0.266]	[0.292]	[0.305]	[0.339]	[0.267]	[0.305]	[0.339]
Pop. density	0.000	−0.000	−0.000#	−0.000	0.000	0.000	−0.000	−0.000	0.000	−0.000	−0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Pop. density squared		0.000#	0.000*	0.000*			0.000*	0.000*		0.000*	0.000*
		[0.000]	[0.000]	[0.000]			[0.000]	[0.000]		[0.000]	[0.000]
Human capital	0.008	0.195**	0.199**	0.163*	0.011	0.005	0.201**	0.163*	0.012	0.201**	0.163*
	[0.029]	[0.089]	[0.092]	[0.090]	[0.029]	[0.031]	[0.092]	[0.090]	[0.029]	[0.092]	[0.090]
Human cap. squared		−0.004**	−0.004**	−0.003*			−0.004**	−0.003*		−0.004**	−0.003*
		[0.002]	[0.002]	[0.002]			[0.002]	[0.002]		[0.002]	[0.002]
ERDF exp. per capita			0.000	0.000#	0.000	0.000**	0.000	0.000#	0.000	0.000	0.000#
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
ERDF exp. per-cap. sq.				−0.000#		−0.000*		−0.000#			−0.000#
				[0.000]		[0.000]		[0.000]			[0.000]

(Continues)

TABLE B2 (Continued)

Dependent variable: *Policy effect* (1 = positive, significant beta coefficients from the first step; 0 otherwise)											
Exp. variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
ERDF exp. per capita NMS							0.000	−0.000	0.000	0.000	−0.000
							[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Constant	−2.900**	−4.725***	−5.074***	−5.011***	−3.298**	−3.614***	−5.405**	−5.003*	−3.682#	−5.405**	−5.003*
	[1.377]	[1.800]	[1.865]	[1.815]	[1.425]	[1.375]	[2.604]	[2.653]	[2.277]	[2.604]	[2.653]
Observations	243	243	243	243	243	243	243	243	243	243	243
N	243	243	243	243	243	243	243	243	243	243	243
$r2\_p$	0.0895	0.114	0.116	0.122	0.0924	0.103	0.116	0.122	0.0927	0.116	0.122
χ^2	26.02	43.48	42.50	n.c.	29.63	n.c.	46.49	n.c.	31.75	46.49	n.c.
p	0.000221	7.13e−07	2.66e−06	n.c.	0.000111	n.c.	1.17e −06	n.c.	0.00010-3	1.17e −06	n.c.

Note: Robust standard errors in brackets.

Abbreviations: EQI, Environmental Quality Index; ERDF, European Regional Development Fund; GDP, gross domestic product; NMS, new member states.

*$p < 0.10$.

**$p < 0.05$.

***$p < 0.01$.

#$p < 0.20$.